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DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY R. J. V. PULVERTAFT, B.A.

SCIENTIFIC ADVISER: A. S. RUSSELL, D.Sc.

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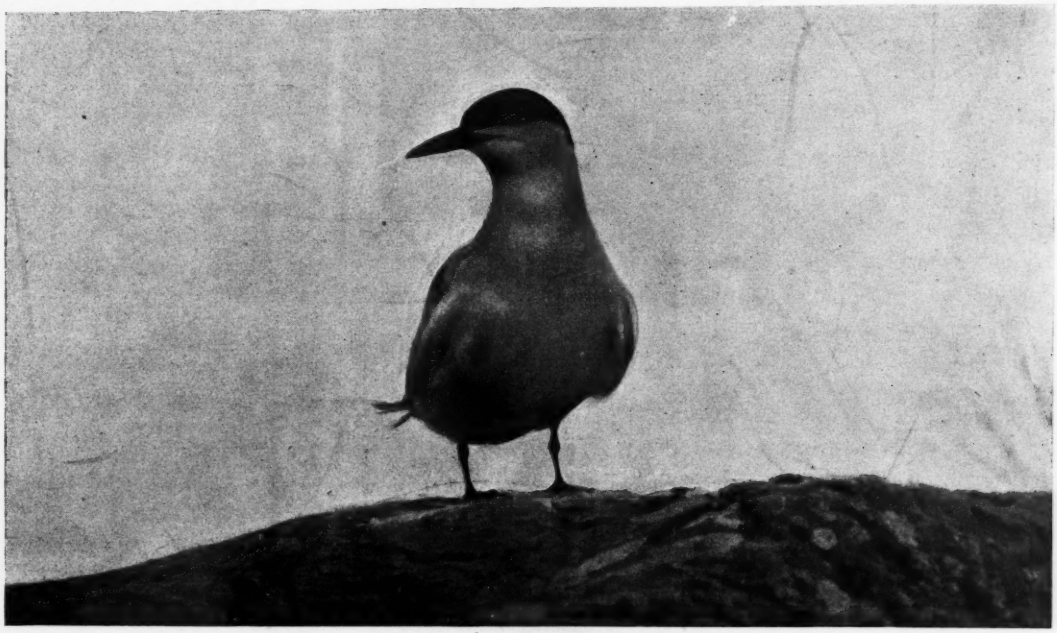

THE COMMON TERN

One of Twenty Species which breed on the Farne Islands

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JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

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DISCOVERY. A Monthly Popular Journal of Knowledge.

Edited by R. J. V. PULVERTAFT, B.A., 23 Westminster Mansions, Great Smith Street, London, S.W.1, to whom all Editorial Communications should be addressed. (Dr. A. S. RUSSELL continues to act as Scientific Adviser.)

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Editorial Notes

THE duties and etiquette of a ghost are not to be learned in a day. In December we resigned ourselves to an untimely death, and bade our readers a long farewell. We rose, nevertheless, unconquered with the New Year. The task of saying good-bye was a sad one, but, alas! familiar in this workaday world. The experience of appearing, a shy "revenant," before the friends who lately mourned our departure, is more novel. Ours has been but a Phœnix-death, after all, and we spring, reinspired and reborn, from the flames.

* * * * *

Our readers will guess that we shared to the full the abundant and—we are well assured—the sincere regrets which our December announcement called forth from many of our contemporaries and from a great number of correspondents. Their comments have inspired us with confidence that we may "catch with our surcease success"; they have given us an assurance that there was a place among journals for an authoritative and popular exposition, in the most liberal sense, of all branches of modern knowledge. We thank them; and even if their letters have, after all, been, as we hope and believe, an unneeded epitaph, we accept them among the privileges which make the conduct of such a journal a pleasure.

* * * * *

A fuller statement of the details of our revival will appear in due course. At present, we may say that it is due to the intervention of a well-known London institution, which in a different way has been devoted to the same interests as those which DISCOVERY has striven to uphold. But it is for our readers to decide whether this revival is to be permanent. We would earnestly ask them to support us, and to introduce DISCOVERY to a wider circle of friends. We ask them also to take us into their confidence, and help us with suggestions and criticism. And if we may take the privilege of a young ghost, or a young Phœnix—who in his only accredited portrait is busy flapping his wings—we may restate here the principles which inspire DISCOVERY, the articles of faith of our enterprise.

* * * * *

We are the apostles of divine curiosity; not seeking sensational items of laboratory gossip, or snippets for cigarette-pictures; but honestly striving to present the world's growing knowledge to our readers in a simple and well-balanced form. We appeal to men and women who know the thirst of knowledge, and are conscious of the healthy shame f ignorance—such as have known the spirit finely expressed in Flecker's "Hassan":

> "We are the Pilgrims, master; we shall go
> Always a little further; it may be
> Beyond that last blue mountain barred with snow
> Across that angry or that glimmering sea. . . .

The adventure stories of to-day are mostly written in the ink of the scientist; and we, following hard on the explorations of microscope and test-tube, do our best to appeal to the man who would have prayed to cross the seas with Drake, or sail south with Captain Cook. But science is not all; those who are familiar with this journal will realise that we have always made a stand against the insularity of the specialist, in science or any other field of learning. We have appealed to him as to one of a multitude of workers, each equally important to those who seek to know where they are in the world and the universe to-day. We are part of the past, for we are the latest result of it; and DISCOVERY tells the story of the ancient world as, page by page, it is newly written by the historian and scholar, as well as by the biologist and astronomer. We are only a part of the present—a small part, we "civilised" Western folk; DISCOVERY fills in some of

the gaps, and presents pictures, when occasion serves, of other nations, other civilisations, other methods of facing the world and its problems.

* * * * *

Julian Huxley, in his collected essays, has dealt faithfully with the Crab, showing how intensely narrow is the field of sensation and experience. It is knowledge and imagination that lift us above the animal world. To some horny-minded persons it is a permanent mystery that anyone should desire knowledge, and not the kind of knowledge merely, useful though it be, which can erect a wireless set or help to earn a living, but such as is of a general and apparently profitless sort. The answer to their questions is, however, simple. There are some pursuits of knowledge which help particular men to earn a particular living ; there is another and a freer pursuit of knowledge that is the stuff of life itself. "What a piece of work is a man . . . in action, how like an angel ! in apprehension, how like a god ! "

* * * * *

Every new fact is a new sense ; every new discovery which we make or even humbly appreciate expands our world. So the scholar among his books may know in his library a universe peopled with friends —towns alive with immortal memories—forests with deep secrets, for him a daily revelation. There should be something of the scholar in all of us ; there has never been an age which had more of the delights of the imagination to offer. DISCOVERY is able, and is organised, to supply the raw material with which a reader can create for himself new worlds to conquer, new castles of the mind to inhabit.

* * * * *

For the treasures of knowledge may be claimed by any man whose thoughts are carried beyond what Bunyan calls the "muck-rake" of daily money-getting to the brighter realities of life. One means recently devised by sociologists of beginning this awakening process is that known as Regional Study ; some account of which, extracted from the report of a recent Congress, will be found on another page. To inquire into the geography, the natural and the human history of even a small region, especially if it be that in which one's own life is cast, in order to understand its economic development, its great or ancient buildings, the names of its places, the nature of its dialect or dialects, and even perhaps something of the early history of the race and races of men that have lived there, is to open many different avenues to the treasure-house, all starting from points of daily experience.

* * * * *

It is a familiar occupation to sit by the fire and endeavour to anticipate the discoveries and advances of the future. In what fields, at present, are there the greatest possibilities for new work and new ideas ? Each specialist will doubtless have his own opinion, and, when the next great discovery is made, it will probably be, as is the way with discoveries, in some unfrequented by-path whose followers the great public has forgotten. In general, however, it appears to us that man's ignorance and impotence are most shown to-day in the things that pertain most intimately to man. The atom, which we shall never be able to see, is more familiar to us than the solution of many a human problem.

* * * * *

The mind of man—the social organisation of man—the health of man—these seem the largest untrodden fields. We walk up and down outside the old fences. How many of our philosophies and psychologies yet can be sure that they are more than frail fabrics of a year's fashion ? And how far from its beginnings has the serious study of economic and social questions, in their widest sense, yet been carried ? In medicine, the conquests which we so proudly (and rightly) acclaim serve to throw into relief the immeasurably greater mysteries still unsolved. It is pardonable to believe that the physician, with a knowledge of human nature and a good share of human sympathy, finds more use in those possessions than in all the drugs in his control.

* * * * *

Men have sought the philosopher's stone and the elixir of life through centuries in the past ; and to-day we laugh at their futile efforts ; but it is strange that we do not see that they were looking for the right things in the wrong way. To turn all things to gold would be useless, and very inartistic ; but the cure for unemployment is worth more than election-time interest. To live for ever in this planet were a doubtful blessing ; but we could all do with a life some twenty years longer, and a hundred-fold healthier. Yet medical research takes only a small place in popular imagination. We all live, and we all must die, and the search for the truest and sanest conditions of these two processes might well be a first charge on the interests of the world.

* * * * *

In a journal with the aim which DISCOVERY pursues it is inevitable that articles shall appear, side by side, of varied and in a sense incongruous nature. We cannot attempt in any one number to weld into a coherent whole the wealth of material which awaits us. Our chief interest will be to hold the scales even, and to present an honest picture of the world's intellectual labours. We shall do our best to maintain the standard which for four years DISCOVERY has upheld ; where we fail to supply a need, we ask our readers to point it out, and if we supply one, we ask them to show their gratitude by obtaining for us the indispensable support of more numerous subscribers.

The Science of a Thermos Flask

By S. H. Groom, B.A.

THE "Thermos" or Vacuum Flask is a very familiar object to everyone at the present time, and most readers have doubtless found it an invaluable companion when travelling or at picnic parties. The general principles of its construction, and the fact that the outflow or inflow of heat is greatly retarded by the presence of double walls enclosing a "vacuum," are also well known, but many may have failed to realise that this popular article of commerce will well repay a more detailed consideration from a scientific standpoint.

First of all, it must be made quite clear that an *absolute* vacuum has never yet been produced in any vessel. Air at normal temperature and pressure contains something like thirty million billion molecules per cubic centimetre, and we should consider that we had obtained quite a good vacuum if this pressure were reduced to one-millionth of an atmosphere. In this case there would still be left thirty billion molecules per cubic centimetre, a figure which sets us thinking of interstellar distances or of the rate of exchange on Berlin. In other words, even the very good vacuum which is the essential feature of the thermos flask probably contains many thousand times as many molecules per cubic centimetre as there are people in the world.

Heat is conducted through air by the movements of the molecules, which at normal temperatures travel at about fifteen hundred feet per second, a speed similar to that of a rifle bullet. Although inconceivably small, the molecules, as we have seen, are also inconceivably numerous, with the result that they frequently collide with one another. In fact, at normal pressures, the average distance traversed between two successive collisions (known as the mean free path) is approximately the two hundred and fifty thousandth part of an inch, and the track of a molecule must be an extraordinary zigzag path changing its direction about 4,500,000,000 times per second.

Suppose now that we start with air at normal pressure between the walls of our flask and reduce this pressure to one-fifth of an atmosphere. The number of molecules is decreased in the same proportion, while the mean free path becomes five times as great as before, say the fifty-thousandth part of an inch. Regarding the molecules as carriers of heat-energy from the hot to the cold side of the enclosure, we have reduced the number of carriers to one-fifth and given each one five times the freedom of motion. The net result is that the rate at which heat is conducted is just the same as before. In other words, *over a very wide range of pressure*, the conductivity of a gas for heat is practically *independent* of the pressure. This result was predicted by Maxwell and has been fully confirmed by numerous experiments.

This being so, the question arises: why is the vacuum employed in the thermos flask so effective in preventing the transfer of heat to or from the interior? To answer this, we must consider what happens when, instead of reducing the pressure to one-fifth of an atmosphere, we reduce it to, say, one-millionth, so that the mean free path of the molecules becomes about 4 inches. This produces a totally different state of affairs in a flask where the distance between the outer and inner walls is considerably less than 1 inch. In these circumstances, most of the molecules will jump right across the space without colliding with each other. Any further reduction in pressure simply reduces the number of carriers of energy; but there is now no compensating factor, since the molecules have already practically reached their limiting freedom of motion. In this case, halving the pressure will also halve the rate at which heat is conducted, so that *at very low pressures* the conductivity of a gas is proportional to the pressure.

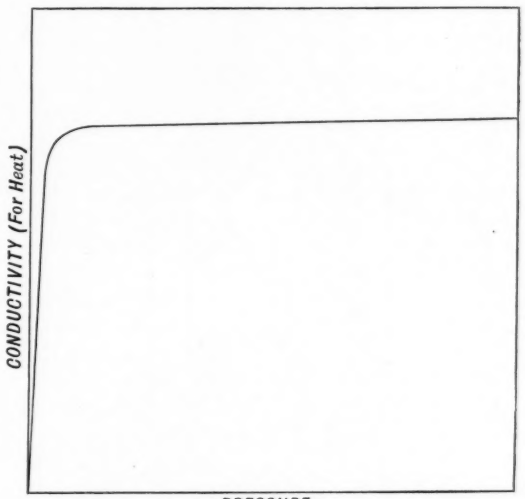

FIG. 1.—RELATIONSHIP BETWEEN CONDUCTIVITY AND PRESSURE.

Heat Conduction and Pressure

Thus, if we plot conduction of heat against the pressure of a gas, we get a graph of the form shown in Fig. 1. For very low pressures the curve rises steadily, while for higher pressures it is practically horizontal. The bend takes place approximately at a point where the pressure corresponds to a mean free path of the

same order of magnitude as the distance across the enclosure in question. This change in direction of the graph is not a sudden one, as there is naturally a considerable range of pressures over which a kind of compromise between the two laws mentioned above holds good. The figure indicates clearly that in pumping out the air from between the walls of a thermos flask, *we must get down to pressures corresponding to the position of the bend* before we are doing any real good. After this point has been reached, the lower the pressure can be reduced the better.

We have next to consider another mode by which heat is transferred across the vacuum-space, and one in

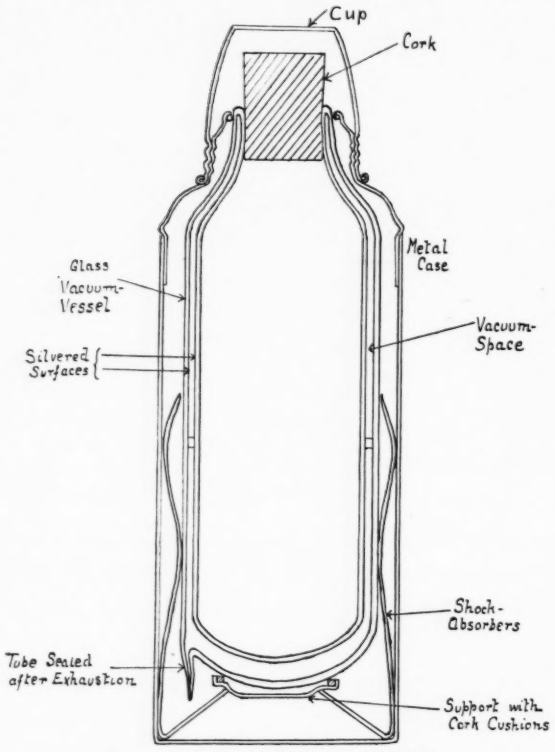

FIG. 2.—A VACUUM FLASK IN SECTION.

which the remaining molecules of air take no part, namely radiation. Heat reaches us from the sun across space where there is reason to believe the amount of matter present is far less than in any vacuum we can produce, and it is generally accepted that this heat-energy is radiated through the agency of ether-waves which differ from light and "wireless" waves in length only. The light waves themselves are, of course, transformed into heat on being absorbed.

It must not be imagined that it is only what we call hot bodies which radiate heat. The molecules of any body not at the absolute zero of temperature (about −460° F.) are in motion, and radiate heat-waves of a length which depends upon the temperature of the body. Standing near a large block of ice, we might be tempted to say that it "radiates cold." Actually it radiates heat, but since we radiate more heat to it than we receive, we experience the sensation of cold. The dominant radiation of the sun has a wave-length of about ·59 thousandth of a millimetre (the wave-length of yellow light). The corresponding figure for the radiation from a kettle filled with boiling water would be about eight of the above units, and for a block of ice, eleven. The lower the temperature, the slower are the movements which set up the radiation, and those familiar with the theory of sound or of "wireless" will know that a lower frequency means a greater wave-length.

Why Vacuum Flasks are Silvered

Radiation, then, is bound to occur across the vacuum-space which we are considering, but we can reduce it by employing highly reflecting surfaces which are invariably bad radiators, and it is for this reason that the walls of thermos flasks are silvered. It should be noticed that the surfaces which are primarily concerned in the radiation are those which form the actual boundaries of the vacuum-space, i.e. those which you would see if you could look round from the interior of that space. It is a very easy matter to silver glass so that the surface *next to the glass* is bright and shining, but it requires considerable care to obtain anything like as good a result at the *free* surface of the silver film.

At the same time, it should be remarked that many surfaces possess a much higher reflecting power for the long heat waves than for the much shorter light waves, as the relation of the depth of the irregularities in the surface to the length of the waves enters into the question. We know from our experience of echoes that sound waves can be reflected by such an irregular surface as the side of a wood. On the other hand, X-rays, which are ether-waves of a length comparable with the distance between the molecules of a solid, cannot be reflected even by a highly polished piece of glass. Metals with a high electrical conductivity, such as silver and copper, are usually good reflectors of heat-waves.

One point with regard to the size of vacuum vessels is worthy of mention. Other things being equal, the rate at which heat enters or leaves the vessel is clearly proportional to the surface of the vessel. For the sake of simplicity, let us consider a cubical vessel, although the argument applies equally well to any other shape. If we double the length of the side of our cube, we multiply the area of its surface by four and its volume by eight. Thus heat can now leave or enter four times

as quickly as before and the vessel will hold eight times as much liquid. Therefore *each gram* of liquid will lose or gain heat at only half the previous rate, and the rate of change of *temperature* will therefore be halved. That is, the larger vessel is the more efficient. This is evidently a case where it may pay to put all one's eggs in one basket and carryone large flask instead of two small ones.

Vacuum vessels were originally devised by the late Sir James Dewar for the purpose of storing liquefied gases, and their use for this purpose came into considerable prominence during the war, when oxygen was required for the use of aviators flying at high altitudes. There were two alternatives, either to carry the oxygen compressed in cylinders, or as liquid oxygen in vacuum vessels. The latter method has certain disadvantages, particularly the inevitable loss due to evaporation, but a greater quantity of oxygen can be carried in a given bulk and the necessary containers are lighter, since they have no great pressure to withstand. In cases where exceptional robustness was required all-metal or porcelain containers were used.

When these vessels are used for storing liquefied gases, an exceptionally good vacuum is highly desirable, and fortunately in these circumstances we are able to obtain much lower pressures than the millionth part of an atmosphere. Charcoal at very low temperatures has the property of absorbing gases to a remarkable degree, and Dewar found that by putting charcoal in the vacuum-space in such a way that it was cooled by the liquefied gas in the vessel, nearly all the residual air was taken up.

There are many other phenomena which could be mentioned in connection with the thermos flask, but perhaps enough has been said to show that the exact *modus operandi* of this familiar object is well worth thinking about.

LECTURES ON ARCHÆOLOGY AT THE BRITISH MUSEUM

By Claire Gaudet

THE Lectures at the *British Museum* by MISS CLAIRE GAUDET on Comparative Archæology will be continued on Thursday, January 10, at 4.30 p.m.

The subject of the Lecture will be, "The Infancy of Classical Architecture," showing the evolution of the Greek Temple from the earliest times.

UNIVERSITY OF LONDON

AMONG the Public Lectures at University College during the Second Term, 1923–4, are the following, which should be of great interest to readers of DISCOVERY:

Friday, February 8, 5.15 p.m.—"Psychology and Medicine," by Bernard Hart, M.D. (admission by ticket, sent free on application to the Secretary).

Wednesday, February 20, 6 p.m.—"The Biometric Study of Cancer," by M. Greenwood.

Wednesday, February 27.—"Inheritance in Finger-prints and the Possibility of their Use in Cases of Disputed Paternity," by Ethel M. Elderton.

The Peace Negotiations of Prince Sixte de Bourbon

By R. B. Mowat, M.A.

Fellow and Assistant Tutor of Corpus Christi College, Oxford

I—THE AUSTRIAN OFFER OF A SEPARATE PEACE

THE Habsburg Monarchy, which blindly began the European War by invading Serbia in July 1914, remained obstinate in its blindness so long as the Emperor Francis Joseph was alive. But with the accession of his nephew Charles to the throne on November 21, 1916, the political attitude of the Monarchy became at once more reasonable. Charles was in no way responsible for the war. As a prince he had no special importance in the Habsburg family until the murder of the Archduke Franz Ferdinand at Sarajevo made him heir to the throne. During the war, until his accession, he was on military service, but not in any prominent way. On his accession, he resolved to work for peace.

The great difficulty was to get into touch with the Entente Governments, for the war had broken off all intercourse, private as well as public. Charles's wife, however, the Empress Zita, had two brothers fighting in the Belgian Army; and it was thought possible to use one of these as intermediary for a peace-offer to the Entente.

The two brothers of the Empress Zita were the Princes Sixte and Xavier of Bourbon-Parma. This younger branch of the House of Bourbon had ruled the Italian Duchy of Parma from the middle of the eighteenth century until it was expelled by revolution from the throne in 1859. Since then the family had lived chiefly in Austria. Prince Sixte was a brother of the Duke of Parma, and when the war broke out he was twenty-eight years old. He had years before this made France his country—holding that a Bourbon must always be French—and had been living for ten years in Paris. He studied at the University of Paris, and gained the degree of Doctor of Laws. It was in 1911 that his sister Zita married the Archduke Charles, who became later the Emperor Charles.

The Outbreak of War

When the war broke out, Prince Sixte, who was an adventurous traveller, was staying at Schwarzau, the family seat in Austria, on his way to the Caucasus. With him was his younger brother, Xavier; Sixte and Xavier were inseparable. They at once decided to return to France, but only obtained permission to leave Austria through the intervention of their brother-

in-law, the Archduke Charles, who had just become heir to the Austrian throne. They arrived in Paris on August 29, 1914, after the French defeat at Charleroi. From that moment Prince Sixte seems to have had the idea that the pressure of the enemy on France should be eased and the war shortened through a separate peace being made with Austria. "But as long as Francis Joseph lives, that will be impossible," he said.

Being refused permission to join the French Army (owing to the anti-royalist laws), the two princes tried the British War Office; refused in this, they tried the Belgian Army, and were at first allowed to become stretcher-bearers, but later received commissions as *sous-lieutenants* in the artillery. Life on the Belgian front, however, did not prevent Sixte from still thinking over his design to detach Austria; and when the Emperor Francis Joseph died on November 21, 1916, the ground was already, to some extent, prepared.

In May of that year the Princes Sixte and Xavier had come into indirect touch with the President of the French Republic when he sent them the Croix de Guerre. In October they went on leave to Paris, and in a conversation with a member of the Cabinet, M. de Freycinet, Prince Sixte put forward his views. These were that the Central Powers depended entirely upon Germany: "it is necessary to beat *one* head." The important thing therefore was to detach Austria: if Austria fell away from the Coalition, Turkey and Bulgaria would be cut off from Germany and would fall away too. Thus the Entente Powers could concentrate their efforts on defeating Germany and on taking the Imperial Crown from the Hohenzollern family; it was the interest of the Entente to break up Prussian domination, but it was not their interest to destroy the Habsburg Monarchy. Thus the object of Prince Sixte was twofold: (1) to enable the Entente to meet Germany alone and so to defeat her quickly; (2) to preserve the Austrian Empire, which could not stand the strain of a prolonged war.

The First Steps

The young Emperor of Austria, immediately after his accession, issued a proclamation saying: "I desire to do everything to banish, in the briefest time, the horrors and sacrifices of the war." A few days afterwards Prince Sixte's mother, the Dowager Duchess of Parma, who was also mother of the Austrian Empress, wrote to the Prince desiring urgently to see him (December 16, 1916). Accordingly Princes Sixte and Xavier, having disclosed the message to the King of the Belgians, obtained leave, and with the full knowledge of the French Foreign Office came to the *rendez-vous*, Neuchatel, on January 29, 1917. There they met the Duchess (at 7 Rue Pommier), who informed them that her son-in-law, the Emperor Charles, was desirous of making peace, and wished the Princes personally to come to Vienna to see him. Everything was already arranged for the visit and for keeping it absolutely secret. If the princes (who, it must be remembered, were combatant officers on leave from the Belgian line), did not think it possible to come to Vienna, a person in the confidence of the Emperor Charles could come to Switzerland to meet them.

The princes returned to Paris to consult the authorities there, who urged them to continue the negotiation. Returning to Neuchatel on February 12, they met the confidant sent by the Emperor (on February 13). This was Count Erdödy. Prince Sixte, who, although only thirty years old, displayed mature wisdom and prudence from first to last, advised that the Emperor should announce by public decree that he was willing to make peace jointly on certain conditions. Thus Germany would be faced with a *fait accompli*. If, however, the Emperor did not feel himself to be in a strong enough position to do this, he could continue the negotiations secretly, and prepare for peace by stating to the Entente what terms he contemplated.

On February 21 Prince Sixte had another interview with Count Erdödy at Neuchatel. Erdödy brought letters from the princes' mother, from Count Czernin, and from the Emperor Charles, all urging him to come to Vienna; half an hour's direct conversation with the Emperor, it was said, was worth two indirect.

So far, the negotiation on the Austrian side was known only to the Emperor, Count Czernin, and the Duchess of Parma; on the French side to M. Poincaré (President), M. Jules Cambon (Secretary-General of the Ministry of Foreign Affairs), and to M. William Martin, Director of the Protocol. M. Poincaré, at a meeting with Prince Sixte at Paris on March 5, 1917, said that he must now confide the matter to his own premier minister, M. Briand, and to the heads of the Russian, British, and Italian Governments. "*M. Lloyd George,*" said the President, "*est un homme discrète.*" There might be some difficulty about Italy. For Russia, the Tsar only need be communicated with. For the moment only indefinite intimation was to be given to France's allies that an offer of peace had been received.

After another interview with M. Poincaré, the Prince was able to put down in writing the minimum terms which the Entente Powers required from the Emperor Charles. Equipped with this document, and with extended military leave from the Belgian Army, Sixte and Xavier again set out for Switzerland, and arrived at Geneva on March 15. Count Erdödy was awaiting them, and the Emperor Charles's overture was discussed at length. But Erdödy's instructions went further than discussion: "this time," he said, "it is absolutely necessary that you come to Vienna." There was a

very real danger that the journeys to Switzerland and the interviews at Neuchatel and Geneva would attract the attention of Germany, and so spoil the whole negotiation. The two princes therefore resolved to go to the enemy's capital. The Emperor Charles gave his word of honour that they could leave Austria as freely as they would enter it.

The Journey to Vienna

On March 20 the two princes informed Erdödy that they would go to Vienna. They started the same evening. Naturally the greatest secrecy was observed: the colonel of police at the frontier had a direct order from the Emperor to let the Count Erdödy and his companions pass without question. Partly by train, partly by motor-car, the princes arrived at Vienna on March 22. They stayed at Count Erdödy's house. That same evening Count Erdödy went out to Laxenburg, a favourite palace of the Habsburg Emperors, a few miles from Vienna, and delivered to the Emperor the letter which Prince Sixte had prepared, outlining the Entente terms.

Next day, March 23, the important interview took place. The princes had remained all day in Count Erdödy's house. In the evening they set out in a closed car for Laxenburg. All was dark. Snow covered the ground. "The auto stopped at an outer court, and an old captain of the Guard, who had the absolute confidence of the Emperor, led them over the park, to the principal façade of the château." They entered by a small door opening on to the staircase of the private apartments of the Emperor and Empress.

Prince Sixte and the Emperor had a long conversation. The views of Charles as regards Belgium, Alsace-Lorraine, and Serbia were found to be practically the same as those of the Allies. With regard to Italy, there might be a difficulty; public opinion in Austria was not prepared for great cessions of territory to be made. With regard to Germany, Austria must in the first instance offer to bring her into the proposed peace: "I mean to be *correct* to the very end," said Charles, "as I shall always be later with you others [the Entente Powers], when we are joined together."

A little later Count Czernin, the Emperor's Minister for Foreign Affairs, was introduced; tall, thin, cold, in frock-coat. Czernin was ready to make peace too, but he would not be precise. However, the Emperor promised that Prince Sixte should have the precise offer of Austria on the morrow.

Next day, March 24, the princes again visited the Emperor at Laxenburg, and received the written proposals. About these the most absolute secrecy was to be observed; any disclosure of them would force the Emperor, in order to put himself right with the Germans, to send Austrian troops to the French front; and this would compromise the whole negotiation. The interview ended, and on the same night the princes, bearing the Emperor's precious letter, left the enemy capital under the snow and were escorted by Count Erdödy into Switzerland. They arrived in Paris on March 30.

The Emperor's Letter

The letter which Prince Sixte brought with him was a fair offer of peace at any rate to France and England. The Emperor Charles wrote:

> "France has shown force of resistance and a magnificent *élan*. We all admire, without reserve, the admirable traditional bravery of her army, and the spirit of sacrifice of all the French people."

The Emperor then proceeded:

> "I will support, by all means and using all my personal influence with my allies, the just French claims relative to Alsace-Lorraine."

Belgium was to be reinstated in full sovereignty, with compensation for her losses. Serbia was also to be reinstated and to be assured "an equitable and natural access to the Adriatic."

With regard to the future of Constantinople, which the Entente had promised to Russia, the Emperor reserved his proposals, in view of the Revolution which had occurred about a fortnight before in that country. With regard to Italy, he wrote nothing at all. He had explained to Prince Sixte that the Trentino might be ceded, but he would not go so far as to offer Trieste. The Emperor's letter was written in pencil, in the French tongue.

Such were the proposals which Prince Sixte was now able to place before the French Government, and there seemed to be a good chance of their being accepted in England as well as in France. Unfortunately, just about this time (actually on March 19) the French Premier, M. Briand, who had been put *au courant* with the negotiations by M. Poincaré, fell from office and was replaced by the veteran parliamentarian, Ribot.

On March 31 Prince Sixte put before M. Poincaré, at the Elysée, the Emperor's letter and the results of his conversation at Laxenburg. M. Ribot, the Premier, did not come to the interview, but M. Jules Cambon, the Secretary-General of the Ministry of Foreign Affairs, was present. MM. Poincaré and Cambon were of opinion that the Emperor's proposals offered the basis of a preliminary separate peace with Austria, if a satisfactory arrangement could be made for Italy. On April 11 M. Ribot met the English Premier, Mr. Lloyd George, at Folkestone, and read to him the letter of the Emperor Charles. Mr. Lloyd George undertook to keep the matter secret. As M. Paul Cambon remarked later to Prince Sixte, Mr. Lloyd George was not "haunted by the fetish of

*

constitutionalism," and was ready, in the interest of all, to keep the Emperor's letter secret even from his own Cabinet. The only thing that now remained to be done was to tackle the Italian question. It was agreed not to inform Italy about the personal intervention of the Emperor Charles (in order to safeguard the Emperor's confidence), but merely to inform Baron Sonnino that an offer of separate peace had been made ; the known presence of the veteran Austrian diplomatist, Count Mensdorff, in Switzerland was a sufficient cover to this mention of a separate offer.

It happened that a meeting at St. Jean de Maurienne had already been arranged for April 19. MM. Ribot, Lloyd George, and Sonnino were to meet to discuss the military situation. On April 18 Mr. Lloyd George arrived in Paris, and Prince Sixte had a conversation with him at the Hôtel Crillon. Their views on the Austrian offer seemed to be in perfect agreement. Prince Sixte, who knew the risk—even of assassination —which the Austrian Emperor was running through personally intervening, urged the necessity of keeping the matter secret. " Mr. Lloyd George, who was leaning against the chimney, came forward to the Prince and said gravely, *I promise,* and held out his hand." The promise was kept.

The meeting at St. Jean de Maurienne took place ; and returning from it, on his way through Paris, Mr. Lloyd George again spoke to Prince Sixte. He narrated the result of the meeting with Baron Sonnino : the Italian Foreign Secretary had absolutely refused to make any separate peace with Austria, unless the full war-aims of Italy were to be realised. But Mr. Lloyd George thought that there was room for negotiation here, and he was ardently desirous that Prince Sixte should continue to keep in touch with Austria. M. Ribot, however, thought that there was no more to be done. For him the matter was at an end, and on April 22 he sent to the Prince, through M. Jules Cambon, a refusal, in the name of the French Government, of the Emperor Charles's offer. It is a curious fact that from the beginning of the " Sixte " affair, until the refusal of April 22, M. Ribot never once himself consented to see the Prince.

(To be continued)

[Most of the documents concerning the negotiations of Prince Sixte have appeared in journals, especially *l'Opinion, le Matin,* and the *Daily Telegraph.* The complete account of the Affair is given with all necessary documents in *L'Offre de Paix Séparée de l'Autriche,* by M. de Manteneyer. It has been excellently translated into English, and published by Constable & Co., in 1921, under the title, *Austria's Peace Offer,* 1916-1917. This work will be more fully noticed at the completion of the article in the next issue of DISCOVERY.]

Plant Breeding—II

By I. B. N.

(Article 1 appeared in DISCOVERY, December 1923)

WHEAT has always been a pillar of civilisation. Once every territory grew its own and by crude methods made its own bread. The world's output has grown to 3,300 million bushels a year, and the international wheat trade is a vast one. In milling, uncannily ingenious machines take the place of primitive hand-stones. In bread-making there are elaborations which " baking " no longer describes. Bread, now, must satisfy a fastidious palate besides filling the stomach. There has been another change—slow, profound, unaided by mechanical ingenuity—in the kinds of wheat grown. With this, as operating in England now, we have to deal.

Always Grumbling

Since the repeal of the Corn Laws, 1846, oversea wheat has increasingly poured into England. Competition has forced down our wheat acreage alarmingly. Now we grow but one-sixth of what we consume, and the price is controlled by the oversea grower. Most of our 1922 crop made less than 30 per cent. above the pre-war price, and therefore involved a loss. Grumbling is the farmer's prescriptive right : he cannot be blamed for exercising it now. If English arable farming is to be saved, wheat-growing must be made to pay. The politicians and the press have submerged us in proposed remedies. Here our concern is a slow but radical remedy—new wheats yielding heavier crops and of greater intrinsic value than the old.

Simplicity Itself

" New " wheats can be made faster even than new books : for the methods the reader may refer to the earlier article. Hybridisation or cross-breeding is the most prolific method, and theoretically it is exceedingly simple. Two parent kinds, each with valuable characteristics, must be selected. By crossing these, a hybrid plant is obtained. Among the progeny plants of this hybrid will be all possible combinations of the characters of the original parents. We have simply to pick the best—the types in which are embodied those features, some from one parent, some from the other, of value to the farmer. Above all he wants great yielding capacity. Other requirements are " strength " or " baking quality " of the grain, " non-lodging " or ability to withstand storms, and " disease resistance." Neither pure science nor mechanical ingenuity can measure plant characters of this kind. This we must realise to appreciate the achievements of plant breeders

in welding combinations of such elusive characters. Experienced intuition is often the only guide. Plant breeding is, indeed, more art than science, though as it advances, pure science affords more and more help.

Disease-resistant Wheat

An outbreak of " rust," a fungus disease, reduced the wheat crop of North-West America, in 1916, from the estimated 360 million bushels to 158 million. While England is not thus ravaged, it is probable that on the average our wheat output suffers a diminution of 5 per cent. from the effects of yellow rust. Not long after the rediscovery of Mendel's Laws of Inheritance, Professor Biffen demonstrated the heritability of resistance to this disease. He found some wheats highly resistant, and in hybridisations this property was transmitted in conformity with the ordered Mendelian scheme. The breeding of a wheat resistant to rust, and yet having the yielding capacity and other characters essential in cultivation, was therefore essayed. Squarehead's Master, a famous old English wheat, was crossed with Ghirka, a Russian wheat whose sole merit was resistance to yellow rust under English conditions. Many of the diverse plants of the second hybrid generation were multiplied on through several generations. Finally the produce of one of them was convincingly proved to possess a combination of the good points of its English progenitor and the rust-resistance of its Russian progenitor. It is now in cultivation as " Little Joss " wheat. Pre-eminent on light soils, it also does well in many parts of the Fenland and is widely cultivated. Historically, this wheat is important, for it is the first product of systematic post-Mendelian plant breeding which for a span of years has retained the farmer's favour.

Two other plant diseases sorely afflict the English wheat crop. Both are produced by fungi, their popular names being " bunt " and " mildew." At present we know of no bunt-resistant wheat, so even the starting-point for breeding has not been reached. Mildew, like rust, can be combated by no preventive measures. In resistant forms alone lies any hope. One kind of wheat is mildew-resistant, but, being of a different species from the bread-wheats, it does not hybridise freely with them. Private enterprise finances the world search for orchids and heavy-weight boxers: enterprise of some sort might well establish a quest of bunt- and mildew-resistant wheats.

Always asking for More

Bigger and yet bigger crops from higher and yet higher yielding wheats is the farmers' perpetual demand. We are, then, confronted with the problem of definitely breeding for higher yield. Never was a more difficult breeding task: perhaps never will be. Why is it that one kind of wheat consistently gives heavier crops than another? A wheat field is simply an assembly of millions of single plants. Does high yield depend on a great average number of ears to every plant, on large ears, large grains, or on what? And how do soil differences and climate affect the yield? These much-assailed questions are still unanswered. They constitute a problem not unlike the reasons for a political majority, though more inscrutable. Lack of knowledge forces us back on the tedious process of " trial and error." High-yielding parents are crossed in the hope that there may result combinations of yielding characters, some from one, some from the other parent, capable of out-yielding all existing kinds. The testing of the hybrid progenies is exceedingly difficult. Differences of 5 per cent. in yielding capacity are very important; but, as explained in the earlier article, they are very difficult to detect. Then, again, a difference demonstrated one year may be reversed under the altered climate of the next. What holds in one county may not apply across the border. Progress here is slow, almost inappreciably slow. Sometimes it seems that it has reached its end. An end there must be, and in England the conscious effort of centuries has gone to the finding and making of higher yielding wheats. Let us turn to the facts. Official statistics date back to 1883, and they indicate scarcely any increase during the last forty years. For this the farmers cannot be blamed: is it, then, that the steady succession of new kinds of wheat has displayed no augmentation of yielding capacity? Further, is it probable that owing to the year-to-year inconstancy of our climate, no new kind will outyield the old ones over an average of years? Optimism alone can prompt a firm denial. But yet, scientifically, the nature of the circumstances which control yield is but vaguely known. Pure science can scarcely be said to have reached the verge of this chasm of uncertainty. No

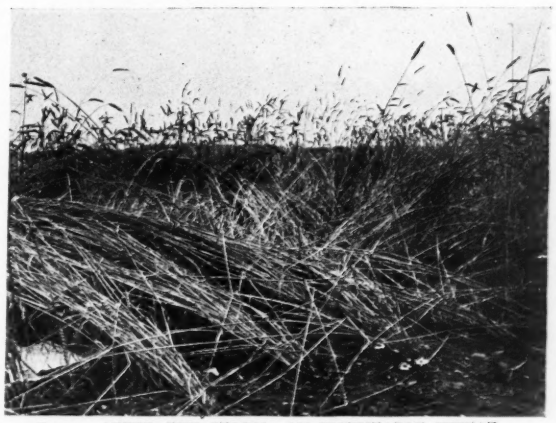

FIG. 1.—AFTER THE STORM: AN UNSUITABLE WHEAT.

news, however, is good news. The empirical methods of the plant breeder will involve him in much labour and discouragement, but hope of some further progress towards satisfying the cry for "more" may not unreasonably be entertained.

Some "accidental" circumstances control yield. "Lodging," or the collapse of the crop owing to the pressure of wind and rain, is an example. To every farmer Fig. 1 will recall harassing experiences. It shows a wheat which is inherently unable to withstand storms. Other wheats have a very considerable standing power. Breeding methods have been applied to the production of "non-lodging" wheats. The problem is perfectly practicable, as Fig. 2 serves to show. In the middle is a short-strawed hybrid wheat

FIG. 2.—AFTER THE STORM: THE CENTRAL ROW OF WHEAT IS UNAFFECTED.

of very great straw strength and standing power. The wheat on the right shows slight evidence of damage: that on the left more evident signs. The photograph was taken after an unusually heavy storm. A second storm would probably beat the left-hand wheat flat, but the middle one is practically non-lodging.

Lodging is not simply the breaking of the straw. Primarily it is the loosening of the root-hold of the plant. Root strain is less in wheats which have a whippy or elastic straw. These broad facts are now clear, but the detail of our knowledge still remains to be filled in. And always in the background lurks an awkward dilemma. The heavier the crop the greater, on obvious mechanical grounds, is its tendency to lodge. Higher yielding wheats, so difficult to breed, must to some extent, therefore, be wheats more prone to lodging. But recent progress, as we shall see, gives us good hope of escape from the dilemma.

Public Opinion

Our urban population cares nothing for the decline of home wheat-growing; but it is firmly insistent on good bread. It wants its loaf light, spongy, even in texture, white, of good flavour, and with a good crust. For this, English wheats alone cannot be used. They are "weak" or of poor baking quality, and give a flat, rather heavy loaf. Millers therefore make a blend of English with "strong" wheats from Canada and other oversea sources, and are usually able to include only from 15 to 50 per cent. English wheats. Only one-sixth of the wheat we consume is home-grown: its price is always below that of the strong imported. The position is therefore that English farmers produce the cheap weak wheats with which the millers "dilute" the strong foreign wheats in making flour for the bread which the consumer demands.

A Protectionist Policy

Let us suppose. Suppose we could produce a wheat with the yielding capacity and the other characters the farmer requires, and, in addition, a strength or baking quality equal to that of the best imported kinds. The demand of English millers would then be for English wheats: the function of imported wheat would be to "dilute" the home product. An abundance of weak foreign wheat is available at comparatively low prices. Naturally we could never grow all the wheat we require. But a preferential demand for English wheat would revitalise the farming industry. It would stimulate home milling also. No less than 10 per cent. of the flour used in England is imported as flour. By this, annually, milling operatives lose £714,000 in wages, and most English mills are now working below their full capacity. There would be no clamorous "food will cost you more," no "politics." In what we have supposed would be the finest imaginable protectionist policy for English farming. There is another factor. Imported wheat has to be railed from port to mill. In aggregate, inland millers expend a very large sum in this way. Can we resist the picture of the inland miller buying most of his wheat from farms near at hand and so escaping the burden of freightage?

So much for supposing: what of the possibilities? They turn on the nature of strength or baking quality and its relation to the English farmer's first requirement—yielding capacity. Cultivated wheats are of three species. The *Triticum durum* forms do not thrive in England: elsewhere one of their common uses is for making macaroni. Only one English wheat belongs to the second species, *Triticum turgidum*. This is Rivet, an old form which yields well on heavy lands. Like all its kind, it gives flat, heavy loaves when baked. Bread wheats, the species *Triticum vulgare*, are, save Rivet, the only forms grown in England and the only ones from which acceptable bread can be made. Among them are very "strong" wheats like the best

Canadian forms, and then a gradation down to typically weak wheats of which English forms are examples. Some wheats, strong in their own country, are weaker when cultivated in England. Others retain their strength in England. Of these, Fife wheat is the best. It and its derivatives make up the great quantities of strong wheat which we buy from America. Fife itself, though probably native to Galicia, reached Canada via Scotland. Crops of Fife which have been grown in England at once dispose of the common fallacy that strong wheat samples cannot be produced under English conditions. But Fife yields only about 20 bushels per acre, which is well below the average of English crops (some 32–33 bushels). These facts were established at Cambridge some years ago. In Fife, then, was a starting-point. Again the familiar breeding proposition was formulated—to hybridise Fife with English wheats and extract from the progeny a form high in both baking quality and yielding capacity.

What is Strong Wheat ?

The expert looks at a sample of wheat, mentally grades its strength, and makes a cash offer. This is experienced intuition: it fails him at times. Sometimes he applies a homely test which any reader may try. Chew a mouthful of wheat, gum fashion, till all the starch is dissolved. There remains a whitish substance, the gluten. Roughly, the more the gluten from a given number of grains, and the greater its elasticity when stretched, the better the baking quality of the wheat. But actual baking of bread under specified conditions is the only real test. For this some 60 lb. of flour are needed, so the test cannot be applied to the small quantities of grain available in the preliminary stages of breeding. Early on in the Cambridge experiments, therefore, efforts were made to discover the chemical nature of strength so that small-scale tests might be devised.

There appear to be two fundamentals. Carbon dioxide gas must be freely evolved to "raise" the dough; the dough must be sufficiently elastic to become distended into a mass of tiny bubbles, and so to give a large spongy loaf. Gassing is the less important, for dough can be artificially "blown up." The elasticity of the dough is derived from the gluten. For high baking quality there must be a big proportion of gluten and it must have great elasticity. Weak wheats have gluten of low elasticity. Thus their flour, as dough, cannot hold the gas, and a rather flat and heavy loaf is baked. Professor T. B. Wood showed that the percentage of nitrogen present, being proportionate to the amount of gluten, is a rough guide to the strength of wheat. Some sharp exceptions were, however, discovered. Proceeding, he found that the elasticity of the gluten was greatly influenced by the presence of electrolytic substances. Phosphates enhanced elasticity, and sulphates made the gluten tough and brittle. The work, though incomplete, was stimulating, and recently an important and entirely new chemical advance has been made (vide H. E. Woodman, *Journal of Agricultural Science*, 1922). It may have important results.

The First Strong English Wheat

It falls to the plant breeder to use the imperfect existing knowledge which pure science is labouring to extend. In 1905 Professor Biffen showed that nitrogen percentage in wheat was a heritable character conforming to the accepted principles of Mendel. From this and many cognate discoveries the theoretical proposition of breeding a wheat for England, high both in yield and baking quality, took on an aspect of practicability. Emphatic success came from a cross of Browick × Fife. Browick is a heavy-yielding English wheat, while Fife is a model of baking quality but low yield. Of many forms resulting from the cross, one was finally selected. It came into cultivation as

FIG. 3.

	NORTHERN MANITOBA. NO. 1.	RED FIFE.	TYPICAL LOAF.	LITTLE JOSS.	YEOMAN.	THE NEW WHEAT.
Volumes	3,275 c.c.	3,475	3,000	2,800	2,825	3,235

All the loaves weigh 2 lb. and were baked under precisely the same conditions. Except Nos. 1 and 3, they are from wheats grown on the same soil at Cambridge.

Yeoman wheat. While probably surpassed by none in yield, it is in baking quality far superior to any other English form. Agriculturally it is a new thing and an asset to farming. Scientifically, as a product of applied Mendelism, it is no less noteworthy. It disposes of the fallacy that baking quality, English conditions, and high yield are incompatible. And it gives us an attractive vista of possibilities.

The Future

With English wheat-growing in rapid decline, it becomes desperately necessary to look into the future. Our old wheats cannot face the competition of strong foreign ones. Can Yeoman or the neo-Yeoman forms do it? It is not easy to review the facts, for the published accounts of the long investigations which bore fruit in the new wheats are of much more than monumental brevity. But the Departmental Committee presided over by the Marquess of Linlithgow has now

given us a compendium of the views of millers, farmers, bakers—and these are the jurymen.

"Yeoman, which crops more heavily than any other variety on typical wheat soils in the eastern counties . . . the straw is also stated to stand well"; it is then a handsome farmers' wheat. The miller comes next. Strong wheats are "free-milling," i.e. the flour can readily and completely be separated from the skin of the grain. In this respect Yeoman is said to be, unlike ordinary English kinds, highly satisfactory. And further, as much as 80 per cent. Yeoman can be included in a blend with strong foreign forms, whereas 50 per cent. is commonly the maximum for home-grown wheat. From good samples, all Yeoman, i.e. all English, loaves of high character can be baked. These the Committee saw and even tasted—with approval. In two recommendations they crystallise their findings: "Millers should also concentrate on the production, advertisement, and sale of guaranteed all-Yeoman flour"; and later: "The general improvement effected in the milling quality of English wheat in recent years, as instanced by the extent to which Yeoman is now being grown, is reflected in the tendency towards revival which is already noticeable in country milling."

Along the whole horizon, so keenly scanned of late, is to be seen no resource of such great and immediate potentiality for the restoration of English wheat-growing as the spread of Yeoman wheat.

But Yeoman will soon belong to the past. We are told there are newer forms. They yield as heavily as Yeoman. Everything turns, then, on their milling and baking qualities. Of these, Fig. 3, already published in the Committee's Report, is eloquent. The loaves in sequence epitomise the history of the production of strong wheats for England and irresistibly point to future possibilities.

Loaf 4. From Little Joss, of strength above English average.

Loaf 3. Typical of what we eat. From a blend of strong foreign with English, its volume exceeds that of loaf 4.

Loaf 5. All-Yeoman, nearly of the volume of loaf 3.

Loaf 6. The best of the new wheats. In volume it exceeds not only loaf 3, but also loaf 1 from the finest imported grade of wheat (No. 1 North Manitoba).

The camera can lie: and so can figures. But caution must not withhold justice from a great breeding achievement nor unduly constrain legitimate speculation. The all-English loaf can be made with profit to the farmer, miller, and baker, and without strain on the popular paunch, purse, or palate. Is it safe to say more? In a mood of "let us suppose" we pictured a reversal of the present order. Foreign was to dilute the equally strong or even stronger English wheat: a premium was to be on the home product. Time alone can decide this. It is so with all the fruits of plant breeding, and therein this art differs from the sciences on which it leans. We may at any rate be hopeful. The new wheats or their successors may yet do more than the politicians in the restoration of English wheat-growing.

The Cultural History of the Pacific

By A. C. Haddon, M.A., D.Sc., F.R.S.

THE cultural history of the Indo-Pacific area, more especially that of Oceania, has been approached from various aspects which have led to diverse conclusions, the latest of which is that which has been elaborated with great skill and erudition by Mr. Perry in his book *The Children of the Sun*. Unless otherwise indicated, the following account is a brief analysis of the thesis advocated by Mr. Perry.

Widely scattered throughout Oceania are the remains of stone buildings, consisting of stone platforms, pyramids, stone walls, occasionally also stone tombs, standing stones, stone circles, and dolmens; even stone houses may occur. These are often associated with irrigation terraces and stone statues. Many of these megalithic structures were in use at the time of the early European voyagers to the Pacific, but some of them even then were derelict. The most extensive and elaborate of these occur in Micronesia, in the Mariannes and the Carolines. Thus, in the past, the greater part of the population in Oceania erected stone buildings, carved stone images, and practised irrigation, or terraced cultivation, or both. On the whole the civilisation of Oceania has suffered a considerable decline, so that present-day communities live alongside remains beyond their capacity to construct.

From the botanical evidence it seems that the founders of Polynesian civilisation came into the Pacific by way of Indonesia, for the bread-fruit, the banana, and perhaps the taro must have come thence.

Botanical and archæological evidence agree in postulating an early period when a stream of civilisation moved out into the Pacific, carrying with it the fundamentals of a relatively advanced culture, which Mr. Perry terms the Archaic Civilisation. Then came a period during which the communication was cut, and the Pacific lay isolated from the West until the coming of the Europeans. Everything points to the con-

clusion that the origins of the civilisations of the Pacific must be sought in Indonesia.

The cultural history of Indonesia suggests that the first food-producing people were more highly civilised than the tribes of the present day. When the old civilisations passed away nothing replaced them, and it is only where their influence extended that cultural progress has taken place.

According to Mr. S. Percy Smith (*Hawaiki*, p. 283), the ancestors of the Polynesians were in India in 475 B.C. A migration to Java took place in 65 B.C., and bread-fruit was discovered in Indonesia in A.D. 50. This was the period of the legendary hero Maui, the son of Tangaroa (p. 153). Polynesians were living in Fiji, and the first mention is made of Samoa and of Hawaii in A.D. 450. About A.D. 650, voyages of discovery from Fiji took place, when most likely the Tahitian groups, the Marquesas, etc., were colonised (p. 175). Ui-te-rangiora made an expedition to the Antarctic, which fired Ara-tanga-nuku, three hundred years later (A.D. 950), to a similar enterprise "to see the wonders of the ocean"; he describes the frozen sea, the icebergs, the sea-lion, and the 500-feet-long leaves of the bull-kelp. Voyages from the south to Hawaii ceased in A.D. 1325, and finally a movement about 1350 landed the great body of the Maoris in New Zealand (p. 283). As Mr. Percy Smith truly says: "Who will deny to the Polynesians the honour that is their due as skilful and daring navigators? Here we find them boldly pushing out into the great unknown ocean in their frail canoes, actuated by the same love of adventure and discovery that characterises our own race. Long before our ancestors had learnt to venture out of sight of land, these bold sailors had explored the Antarctic Seas, and traversed the Pacific Ocean from end to end. . . . More often than not they made these adventurous voyages with the definite object of establishing new colonies in which to settle, taking with them their *Lares* and *Penates*, their domestic animals, seeds, plants, and families" (pp. 178–9).

The Melanesians have no traditions of migration into their region; they claim to have been created on the spot. Some of them now use megalithic monuments of types not now made in Polynesia. They have retained more connection with the past, but there has been loss of culture; but San Cristoval, the New Hebrides, and New Caledonia seem to stand nearer in culture to the archaic civilisation than any part of Polynesia at the present day. The Polynesians, however, continually have lost certain elements of their culture while moving from place to place.

The Children of the Sun

Ample evidence exists to show that the early chiefs in Polynesia were equated to gods. A Tahitian king, by virtue of his coronation ceremony, was made into an incarnate god. There are traces of the existence in the past of a sun-cult, and the chiefs were Children of the Sun; these were characteristics of the archaic civilisation. The same holds good for those parts of Melanesia and Micronesia where signs of the archaic civilisation are most prominent, the Children of the Sun form the ruling class, and the same obtains in Indonesia.

The sun-god has almost universally been replaced, usually by a war-god, and there has been a corresponding change in the habits of the communities. Thus the inhabitants of the Carolines formerly had the Children of the Sun as rulers; then came invaders who broke up the former civilisation, and most of the important Polynesian gods are war-gods, who often have demonstrably displaced solar gods. In Oceania there is plenty of evidence to show that the earlier people were probably peaceful. When communities give up their peaceful habits and take to fighting on a large scale, attention is diverted from one occupation to another. In the Pacific, the rise of warfare coincides with the degeneration of culture in the arts and crafts.

According to Mr. Perry, everywhere the aboriginal inhabitants of a country were peaceful food-gatherers, with little or no social organisation, wandering about in family groups.

Then there arrived at various points—India, Cambodia, Polynesia, Mexico, etc.—an advanced civilisation based on irrigation, located near sources of wealth of various sorts, gold, pearls, and pearl-shell being the most important, and characterised by stone-working, and other arts and crafts. Some of these early settlements were obviously only there for the purpose of mining, and no attempt was made to colonise the country. But in others, settled communities and even cities sprang up which were ruled over by divine kings, usually claiming descent from the sun.

This archaic civilisation gave rise to others less advanced in the arts and crafts, but more warlike, and naturally with war-gods; but the rulers of the later communities were not divine kings. Directly to these warlike habits may be ascribed the ultimate disruption of the archaic civilisation.

The Children of the Sun were looked upon as gods; they were accredited with great powers; for instance, they were supposed to control the weather, fly through the air, visit the world in the sky, and do all manner of things impossible to mortal men, and when they died they returned to the sky, whereas the commoners were relegated to the underground world.

It is reasonable to believe that the war-gods—who were once men—throughout the Indo-Pacific were actually members of the ruling group of the archaic

civilisation; originally they were but semi-divine. The warrior nobility at death passed to the underworld, like commoners, and the war-gods, too, are connected with the underworld.

Melanesian culture-heroes belong to the sky-world, and then, with the culture they introduced, must be relegated to the archaic civilisation; but they do not receive any active cult, for the religious systems of the Melanesians are centred round ghosts of ancestors.

The Givers of Life

Polynesia, with its hierarchy of gods and priests and elaborate ceremonial, stands in strong contrast to Melanesia. When the Children of the Sun disappeared, the worship of sky-deities declined; but in many cases the rites that they instituted have persisted in what are generally termed magical practices. Indeed, Mr. Perry suggests that the magical rites of any tribe are centred about certain "Givers of Life" which derive their powers from historical association with the archaic civilisation.

If the later ruling class has been derived from the archaic civilisation, then the archaic nobles, at least, must have formed two groups, one associated with the sky, the other with the underworld.

The archaic civilisation in its earliest phase was characterised by a belief in a Mother-goddess, the ruler of the underworld, associated with agriculture and human sacrifice, the latter degenerating into cannibalism and head-hunting. The earliest food-producers in Melanesia were matrilineal, and there is evidence that throughout the Pacific mother-right has given place to father-right, and gods are now in the ascendant, with a Great Mother in the background. The transition was accompanied by other cultural changes, such as the development of warfare, the disappearance of the Children of the Sun, etc.

A dual organisation, with marriage between the moieties, is characteristic of the archaic civilisation. Primarily it seems to have been confined to the chiefly classes, but ultimately, according to Mr. Perry, it was extended to the whole of the community; when the solar chiefs disappeared, so did the duality of the sky and underworld, but the other side of the ruling group artificially set up a like organisation which naturally was associated solely with the underworld.

What is known as totemism appears also to be associated with the archaic civilisation. The essence of the system is the clan, which originally was matrilineal, for the clan plays an important part in the political life of the community. Each member of the archaic nobility was associated with an animal, which was an ancestor, or was simply used as an ensign. "The conclusion, therefore, is that the totemic clan, as part of the political constitution of the tribe as a whole, really centres round one family, that family which claims direct descent from the animal ancestor that gave rise to the clan."

Marriage Rules

Mr. Perry's investigations point to three stages of development of marriage rules: (1) marriage forbidden between members of the same moiety, (2) of the same clan, (3) between blood relatives. It appears that the practice of intermarriage formerly held between the two branches of the ruling groups of the archaic civilisation, and was extended to the clan system; but when the clan grouping disintegrated, marriage was forbidden within certain degrees of kinship; the earlier stages did not prevent the marriage of certain kin.

The main thesis propounded by Mr. Perry may be summarised very briefly in the statements that everywhere aboriginal peoples were essentially peaceful and had a very primitive culture. Then the carriers of the archaic civilisation arrived in their search for wealth and Givers of Life; they too were peaceful and had a sun-cult with sky deities. The old regime was suddenly closed by the rising to power of war chiefs, who naturally adopted war-gods, and the resultant turbulence induced cultural degeneration. Warlike tendencies, on the whole, have dominated the world ever since the Children of the Sun were destroyed by the Inheritors of the Underworld.

Enough has been said to give a general idea of the cultural elements which characterised the main features of the archaic civilisation, which Mr. Perry traces back to the Fifth and Sixth Dynasties of ancient Egypt, i.e. about 2750–2475 B.C.

The reason assigned for the voyages in the early dynasties was to procure the materials for mummification and funeral rites, which objects were regarded as "Givers of Life," as well as to obtain gold, pearls, and other valuables, which themselves had a ritual significance. It would then follow that this quest originated in Egypt and proceeded thence to contiguous countries and lands afar off.

Accepting the statements of Professor Elliot Smith, we have to assume that the Semitic-speaking Phœnicians exploited South India, but left no trace of their language or distinctive religion. The same applies to Further India and Indonesia. The occurrence of certain funeral customs in San Cristoval, in the Solomons, suggests a very close connection with Egypt of the Sixth Dynasty; but here, again, Semitic cultural influences are lacking and the peoples speak an Austronesian language; the same obtains for the rest of Melanesia, and for Polynesia and Micronesia. The type of mummification found in Torres Straits and Northern Australia, according to Professor Elliot

Smith, shows signs of Egyptian technique of the Twenty-first Dynasty, about 1090–945 B.C., which points to a very much later cultural movement than that which we are now considering. The civilisation of ancient Mexico as summarised by Mr. Perry shows such close resemblances with the archaic civilisation as to afford a strong presumption that it was derived therefrom, and also that the culture-bearers had not remained for any appreciable time in Polynesia; indeed some cultural features seem to indicate that there was direct and rapid communication between Mexico and Southern Asia. Here again the physical characters and the languages of Central America do not now present any Phœnician characters.

The Migration from Egypt

If we acccept the main thesis advocated by Mr. Perry of the eastward spread of a complex civilisation from Egypt four to five thousand years ago, the mechanism of this spread requires to be critically studied, the linguistic difficulties faced, and a relative chronology suggested.

The first stepping-stone, India, of this spread presents no difficulty. It seems impossible to escape from the conclusion that the first extension of the archaic civilisation in Melanesia was due to Austronesian-speaking peoples, originally from the mainland of Asia and immediately from Indonesia. There is sufficient evidence that the Polynesians came from Indonesia, the earlier of them, perhaps, with an intermediate stage in Melanesia. It is difficult to avoid the conclusion that Melanesia was visited directly by Maritime Armenoids, Phœnicians, or whatever they may be called; indeed, as we have seen, there appears to be a trace of this physical type among existing Polynesians. The language difficulty is sufficient to preclude the view that Polynesia was originally colonised by the Phœnicians or allied voyagers. The Rev. Dr. C. E. Fox has found that the members of the Araha clan of San Cristoval embalm their dead chiefs and place them in cavities hollowed out within mounds, often made of stone and shaped in pyramidal form with flat tops, so that they resemble the mastabas of early Egypt. From the surface of the mound of San Cristoval a shaft leads down to the recess within which the body lies. On the top of the mound there is often a structure consisting of a table-stone resting on three or four uprights, having the characteristic form of a dolmen. On or by the side of this dolmen stands an image in human form, carved out of coral or stone, which is believed to represent the dead man, and to act as the abiding-place of the soul which left his body at death.... The statue is in a seated posture, and at the back of the head a pigtail-like structure reaches down to the stone surface upon which the image is placed, thus reproducing a feature of the statues of Cheops, Chephren, and Mycerinus, the builders of the great pyramids of Egypt (Rivers, 1922, p. 16) [i.e. Fourth Dynasty kings: Cheops, 2900 B.C.].

The parallelism of this and of other customs referred to by Dr. Rivers to similar customs of ancient Egypt of the Pyramid Age is so striking that it cannot be ignored; indeed, Rivers had elsewhere said: "These funerary customs bear so close a resemblance to those of Egypt as to leave no reasonable doubt that travellers imbued with the essential ideas of Egyptian culture reached San Cristoval and introduced, not only burial in pyramidal structures, but also the custom of erecting a statue to serve as the abiding-place of the ghost of the dead man" (1920, p. 68).

The exact way in which this and other customs reached Oceania is at present obscure, but a great deal of exciting information is constantly coming to light, and it is evident that we have only just begun to appreciate the extreme complexity of the problems connected with the human occupation of the Pacific.

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SHAKESPEARE'S OWN HAND

WE are glad to be able to promise our readers in the March number an account of the recent discovery of what is believed to be a considerable quantity of Shakespeare's own writing attached to a play of Sir Thomas More's, from the pen of Sir Frederick Kenyon, K.C.B., Director of the British Museum and formerly President of the British Academy, whose authority is well known to students and others in all questions of palæography.

Some Minor Methods of Divination

By W. R. Halliday, B.A., B.Litt.

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THE two great motives which have secured for magic and superstition their invincible hold upon the human mind are the desire to get even with an enemy and a craving to know the future. So powerful an element, in fact, was divination in mediæval magic that the word "nigromancy" or "negromancy," which is a corrupt form of "necromancy," or divination through the spirits of the dead, was commonly used to signify the Black Art, and popular etymology was brought in to transform the origin of the first part of the word from the Greek *nekros*, a corpse, to the Latin *niger*, black.[1] A cursory glance at the treatises directed against witchcraft will also reveal how large a part was played by the motive of learning the future in giving to magic its vogue. Nor is that motive dead to-day; crystal-gazers, palmists, and fortune-tellers of different shades of reputability abound in all civilised countries and in all strata of society.

The various methods by which the future is ascertained are for the most part of great antiquity, although the reasons assigned for their alleged efficacy have varied in different times and places. Crystal-gazing ancient and modern I have briefly discussed in a previous number of DISCOVERY.[2] It may prove not uninteresting further to pass under review some of the minor divinatory rites, which have but recently died out amongst us or still survive, either in the practice of the superstitious or as pastimes which are taken at best but half seriously.

The Bowl of Water

The bowl of liquid may be used otherwise than as a mirror for divinatory purposes. Sometimes it serves merely as a receptacle into which lots are thrown. This occurs in one of the comedies of the Latin dramatist Plautus,[3] and in a Scottish trial for witchcraft Betty Skebister was accused of having cast coins into a vessel of water to discover the health of absent parties: "Gif the cross of the sixpence be up, then they are weill; gif not, they are not weill."[4]

The cup which Joseph hid in Benjamin's sack was that "in which my lord drinketh and whereby he indeed divineth."[5] The ancient Greeks drew inferences about the future from the movement of the liquid or the sound of the splash caused by throwing objects into a vessel of water.[6]

In *Folk-lore* for June 1923 my friend Professor Rose has described a method of divination tried on behalf of one of his children by their nurse. Last thing at night on Midsummer Eve put out a glass of water for each person whose fortune is to be told; into each glass put the white of an egg. At noon inspect the shape taken by the white of the egg. In the particular instance the shape detected was that of a church with an awning, which was interpreted as signifying a marriage.

This method of telling the future was recorded by John Aubrey in 1686 as one of the "customs of Eaton Schoole."[7] Melted lead was similarly used in the seventeenth century in England "to learne whether the sick man was bewitched or not."[8]

In modern folk-practice the custom is widely distributed. It is common in Asia Minor, Macedonia, and the Greek islands; it is recorded among the Finns (stearine and melted lead), Russians (wax), Danes (lead and egg), Ruthenians (candle wax), and Magyars (lead).[9] I have been told of it as a nursery game both in Germany and Scotland. Its antiquity is more than respectable, for the wise men of Babylon divined by dropping oil into water.[10] A reference to a similar practice in Greece of the fifth century B.C. has been detected by Dr. Farnell in Æschylus, *Agamemnon*, l. 322.[11]

Allied in principle to this method of divining is the common superstition of fortune-telling from the dregs of the teacup, in which the arrangement and apparent shape of the leaves supply the required indication of the future. Somewhat similar, again, is the practice of an African tribe in deciding the event of an illness. The medicine-man makes incantations over a pot of

[1] "Mantia, Græce divinatio dicitur, et nigro, quasi nigra, unde Nigromantia, nigra divinatio, quia ad atra dæmoniorum vincula utentes se adducit." See Comparetti, *Vergil in the Middle Ages*, p. 291.

[2] DISCOVERY, IV. 41, May 1923, pp. 127–9. By an oversight I there omitted to refer the reader to the full and most interesting account of personal experience of Moslem crystal-gazing in Lane, *Modern Egyptians*, chapter xii.

[3] Plautus, *Casina*, 295. (Translation by Nixon, Loeb Classical Library.)

[4] Dalyell, *The Darker Superstitions of Scotland*, p. 512.

[5] Genesis xliv. 5.

[6] Bouche Leclerq, *Histoire de la Divination dans l'Antiquité*, I, p. 185.

[7] Aubrey, *Remaines of Gentilisme and Judaisme* (Folk-lore Society, 1881), p. 133.

[8] Reginald Scot, *Discoverie of Witchcraft*, 12th Booke, cap. xviii.

[9] The references in detail may be found in my *Greek Divination*, p. 147, except for the Ruthenians. Here candle wax is used in water by girls on St. Andrew's Eve to find out future husbands. *Folk-lore*, xxv, p. 196.

[10] Jastrow, *Aspects of Religious Belief in Babylonia and Assyria*, pp. 146, 282.

[11] Farnell, *Greece and Babylon*, p. 301.

water, after which powdered herbs are sprinkled on the water or a number of short sticks an inch long are dropped in. According to the position assumed by the powder or the sticks, the medicine-man reads the augury.[1]

Another method of divination with a cup of water, wine, or liquid is to throw objects into the liquid and to draw conclusions from whether they sink or swim. Thus in the *Satyricon* of Petronius Arbiter, the leader of fashion at the court of the Emperor Nero, who was put to death on the charge of high treason in A.D. 65, we read: "She stood a jar of wine under my hands and made me stretch all my fingers out, and rubbed them with leeks and parsley, and threw filberts into the wine with a prayer. She drew her conclusions from them according as they rose to the top or sank."[2] Similar was the method adopted, according to legend, in the partition of the Peloponnese between the conquering Dorian chieftains. "Temenus took a pitcher with water in it, and dropped into it the lots of Cresphontes and the sons of Aristodemus, an agreement having been made that they whose lot came up first would have first choice of the land." Legend told also how the affair was rigged, one lot having been prepared of earth and the others of stone or baked clay.[3] In the Deccan after each Muharram, the dramatic festival in which the Shia Moslems celebrate the martyrdom of Husain and his brother, rods crowned with Husain's horseshoe are thrown into a well. "Before the next Muharram all those who have thrown their rods into the well go there and await the pleasure of the martyr, who makes the rod of the person he has chosen to represent him to rise to the surface."[4]

It may be noticed that the affinity between rites at holy wells and smaller scale operations in a basin of liquid, which we noticed in the case of the magic mirror and the mirror-well,[5] holds good for all methods of divination in which the instrument is a bowl of liquid. Both at wells and in bowls of water, the attention is concentrated in one set of rites upon the rising of the person or object to the surface, in another upon the person or object being sucked down. Thus in the first category comes the practice of witch swimming, which has been used as a practical test of the guilt of those accused of witchcraft in Assam, Arabia, and Burma, as well as in this country. In antiquity the statement that the Thibii, notorious magicians from Pontus, could not be sunk in water, goes back to the Greek historian Phylarchus in the third century B.C. Upon a similar principle barley loaves were thrown into the water of Ino at Epidaurus Limera; if the loaves floated, it was a bad sign. A like phenomenon was reported of a lake at Aphaka, in Syria. The idea which seems to underlie these practices is that explicitly formulated by King James I of England, viz. that the holy element refuses to receive the guilty person or his offering.

Examples of the same principle at work in divination by the bowl may be seen in a method of detecting thieves which is used in North Africa, Sweden, and India. The names of suspected persons with magical formulæ are written on slips of paper, which are then enclosed in balls of paste and put into a bowl of water. The name of the guilty person will come to the top.[6]

An example of the converse principle, that the guilty party or his representative sinks, is provided by the oath ordeal in classical antiquity at the tarn of the Paliki in Sicily. The oath was written on a tablet and thrown in; if the man were forsworn, the tablet sank. In a Malay oath ordeal two boys take the contradictory oaths, which are written out and sealed in bamboo tubes, and dive into the water. The boy who has the false oath is half drowned. In England and Scotland the sinking of a billet inscribed with a suspected name, when thrown into holy water, reveals the thief, and the apparel of an invalid similarly immersed betokened health if it swam, death if it sank.[7] A famous white witch of County Clare in

[1] Canon Roscoe in *Folk-lore*, xxxiv, p. 31.

[2] Petronius, *Satyricon*, 137. (Translation by Heseltine, Loeb Classical Library.)

[3] Pausanias, iv. 3, 5. (Translation by Sir J. G. Frazer.) See also Apollodorus, ii. 8, 4. (Translation by Sir J. G. Frazer, Loeb Classical Library.)

[4] Crooke, *Herklot's Islam in India* (Oxford, 1921), p. 163.

[5] DISCOVERY, IV. 41, May 1923.

[6] References in *Greek Divination*, pp. 110 foll. Analogously in classical antiquity it was a bad omen if the flames rejected offerings thrown into the craters of Etna or the frankincense placed upon the natural jets of flame which issued from fissures in the ground at Appollonia. In the Solomon Islands, when food is offered in the fire to ghosts, the sacrificer prays for whatever is desired. If the fire blazes up and consumes the food, it is a good sign. Frazer, *The Belief in Immortality*, i, pp. 367–8. The reference for thief detection in India is Crooke, op. cit., p. 275.

[7] For references and further examples see *Greek Divination*, pp. 113 foll. To those there given may be added the chastity ordeal in Achilles Tatius, a late classical writer of romances, who lived probably at the end of the third century after Christ.

"She writes her oath on a tablet, which she then suspends by a string round her neck. If she has sworn a true oath, the spring remains in its place; but if she has perjured herself, the water boils up, rises to the height of her neck, and covers the written tablet." Achilles Tatius, viii. 12, 8. (Translation Gaselee, Loeb Classical Library.)

A similar spring occurs in the romance written by the Byzantine Eustathius or Eumathius (viii. 7, 2, and xi. 17, 5), a feeble imitator of Achilles Tatius who may have lived in the twelfth century A.D. Here the water rises and carries off the laurel crown of the girl if she has been unchaste, and a statue of Artemis bends its bow at her. A true mediæval touch this last of the talisman statue! The converse to these

the middle of the last century used to foretell the death and recovery of her patients by a shamrock leaf in some fluid in a bottle; if it rose, they recovered, if it sank, they died.[1]

The Pendulum

A cup of water is sometimes used in the pendulum rite. Thus at Cleveland girls take a tumbler of "south-running water," borrow a wedding-ring, suspend it by a hair of their heads, and hold it over the glass of water. If the ring hit the side of the glass, the inquirer will die an old maid; if it turn round quickly, she will be married once; if it turn slowly, she will be married twice.[2] In Durham a shilling is used instead of a ring, and in fact the "south-running water," the cup, the wedding-ring, and the hair are what may be called magical trimmings. Any heavy object suspended by a cord and held in the hand will automatically begin to oscillate. This may easily be tested by experiment; it is also shown by the variation of the instrument in the magical practice of mankind. Thus in different parts of the world a bangle (Sgau Karens), "something often used" (Chukchi), stone or heavy ornament (Melanesians), lemon (Malays), or stones and antique arrowheads (Cherokees) are employed with equal efficacy. In Europe, however, a ring is usually the instrument. In nurseries the pendulum is sometimes used in one of the many games for telling "what o'clock is it?" It was once recommended to me by a friend as a means of determining the sex of eggs. If the oscillation is circular, the chicken will be female, if straight, male. I have also been present at a séance where the pendulum was more or less seriously requested to give answers by code rappings against a tumbler. It is a simple and natural elaboration to arrange a circle of letters or names to which the pendulum may swing. This device is not unknown in the Lower Culture, and it is recorded that in the fourth century after Christ the conspirators Patricius and Hilarius used a pendulum suspended in a round basin, which had letters engraved on the rim, to discover who was to be the successor of the Emperor Valens.[3]

The supposed magical cause of the swinging of the pendulum has varied among the different peoples who have practised or practise it. The agency of a spirit invoked for the purpose, the justice of God, or, to quote my hostess of the séance, who was convinced that, unless the ring was suspended by a human hair freshly pulled, it would not work, "personal magnetic forces" are variously thought to be responsible. The actual physical cause would seem to be unconscious muscular action; this gives a series of short tugs which, like the short pulls of a bell-rope, sets up oscillation. Those who are loath to be content with a purely mechanical explanation may fall back with Sir W. F. Barrett upon the unconscious self as a directing agency.[4] This, like so many similar matters, appears to me to be beyond the region of proof or disproof, and the inquirer's attitude is likely to be determined by his temperament or predilections.

Dowsing

The same perhaps is true about the efficacy of the dowser's rod, which is regarded by Sir W. F. Barrett as an autoscope of a similar character. Here I am personally more sceptical than the editor of DISCOVERY,[5] though I cannot claim to have first-hand experience of its experimental testing. I cannot disprove the truth of its claims, but I do not personally believe in them. Historically I notice that the limitation of the dowser's claims to the discovery of water is quite recent. Its more popular claim, and one the exercise of which would be far more profitable, has been that professed by Dousterswivel in the *Antiquary*, viz. the discovery of metals or of hidden treasure.[6] Nor is the dowser's wand invariably the forked stick; e.g. in the tale of *Ala al-Din Abu al-Shamat*, Ahmed Kamakim "took in his hand a rod made of bronze and copper, iron and steel."[7]

As far as the history of classical superstition is concerned, the problem of the dowser's rod is irrelevant, for, so far as I am aware, there is no reference to it in classical literature. The *virgula divina* in Cicero, *de Officiis*, i. 44, is not a divining-rod but a magical wand, and the rhabdomancy, or divination by rods, to which there are classical references, was a mode of divination common both in ancient and in modern times in the Middle East, in which a bundle of marked arrows or sticks are shaken until one of them drops out.

springs are those which dry up at the approach of a guilty person. Near Phárasa, in the Taurus, I visited a spring reputed to have its source in the eyes of St. Chrysostom which possesses this property. Its waters on that occasion continued, I am glad to say, to flow profusely. For a Cretan example, the history of which goes back at least to Venetian times, see Pashley, *Travels in Crete*, i, p. 88.

[1] Westropp in *Folk-lore*, xxii, p. 205.

[2] Henderson, *Folk-lore of the Northern Counties*, pp. 106–7.

[3] See Tylor, *Primitive Culture*, 2nd edition, i, pp. 127–8, and references in *Greek Divination*, pp. 218–19.

[4] Sir W. F. Barrett, *Psychical Research* (Home University Series), cap. ii.

[5] See Editorial Notes in DISCOVERY, II. 15, March 1921.

[6] See Sir W. F. Barrett, op. cit., cap. xii.

[7] Burton-Smithers, *Arabian Nights*, iii, p. 198. The mixture of metals has a supposed efficacy in the manufacture of magical apparatus. Cf. the magical wand in Burton-Smithers, op. cit., iv, p. 314, or the basin used by the conspirators against Valens, which was made of a mixture of metals.

Divination from Inspired Writings

A favourite method of seeking encouragement or deciding the choice between alternative lines of action has been the random opening of some great work of literature, whether sacred or profane, and the interpretation of the passage, upon which the questioner's eye may fall, to suit the peculiar circumstances of his case. In classical antiquity the works of Homer and Vergil were thus consulted. St. Augustine refers to the common practice of this reference to the pagan poets, and accounts for its frequent efficacy by the chances of coincidence [1]; his own life was very considerably affected by the text upon which his eye fell, when he heard the mysterious child's voice repeat, "Take up and read." [2]

It was indeed inevitable that Christians in doubt should turn to their inspired writings. In these islands Vergil and the Bible remained the two great books from the chance reading of which the future might be revealed. Thus one of the murderers of Archbishop Lang in 1679 was confirmed in his purpose by hitting upon the texts, "Go on and prosper" and "Go, have I not sent you?" [3] and Charles I read in the copy of Vergil which is still to be seen in Bodley's Library at Oxford, the presage of his tragic fate.[4]

In the Moslem East similar *sortes* have been and still are taken both from the Koran [5] and from certain secular authors. Thus Tamerlane's design of invading India was confirmed by a consultation of the Koran which yielded the text, "O Prophet, fight with the infidels and the unbelievers." [6] The works of the Persian poets Saadi [7] and Hafiz [8] are similarly consulted, and if Vergil enjoyed the distinction of oracular repute almost within a century of his death, for the Emperor Hadrian is known to have affected the *Sortes Vergilianæ*, there is a story which attributes to the works of Hafiz a reputation even more rapidly acquired. It is said that when Hafiz died, his enemies raised the question whether he should be buried as a Moslem, because by publicly drinking wine and praising its use he had become a Kafir or infidel. A number of couplets written by the poet were thrown into an urn, and a child, instructed to draw one of them, drew forth one which ran:

> "Fear not to approach the corpse of Hafiz;
> Although stained with sin, he will enter heaven." [9]

[1] Augustine, *Confessions*, iv. 3, where Vindicianus (cf. ibid., viii. 6), St. Augustine's shrewd, experienced, and distinguished friend, dissuades him from being deceived by the apparent successes of astrology in making valid predictions by the argument that they may be accounted for by the same coincidence which is responsible for the applicability of the words of a poet, who was writing about something quite remote from the questioner's problem.

[2] *Confessions*, viii. 12.

[3] Dalyell, *The Darker Superstitions of Scotland*, p. 522.

[4] D. A. Slater, *Sortes Vergilianæ, or Vergil and To-day*. (Basil Blackwell, 1921.)

[5] Lane, *Modern Egyptians*, p. 260; Crooke, *Herklot's Islam in India*, pp. 61–2; Burton-Smithers, *Arabian Nights*, ii, p. 75, iv, p. 12.

[6] Sykes, *History of Persia*, ii, p. 207.

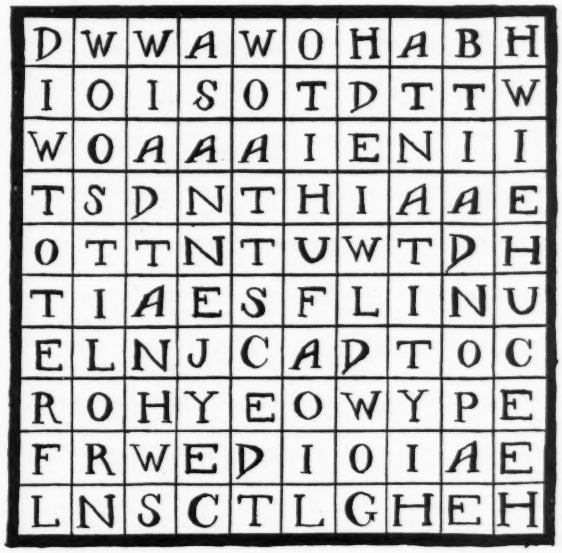
[7] Morier, *Haji Baba of Ispahan*, cap. xii.

[8] Crooke, loc. cit.

[9] Sykes, *History of Persia*, ii, p. 333.

Divination by Lot

The method of writing out slips and drawing one of them brings the consultation of the inspired book into essential harmony with another of the methods of divination by lot. It is a common device to start



A MAGIC TABLE.

with a series of answers to possible questions, and for the questioner in some way to select, arbitrarily and at hazard, one of these. Lucian satirically suggests that this is really the best way to resolve philosophic doubt and to make your choice between the rival systems. "Or, if you like, I can suggest a still simpler way; you need not shed all this blood in sacrifice to any god, nor employ an expensive priest; put into an urn a set of tablets, each marked with a philosopher's name, and tell a boy (he must be quite young and his parents both be living) to go to the urn and pick out whichever tablet his hand first touches." [10]

In ancient Italy this mode of divination appears to have been particularly popular, and the famous *sortes* of Præneste consisted of a number of answers inscribed

[10] Lucian, *Hermotimus*, 57. (Translation by H. W. Fowler and F. G. Fowler in the Oxford Library of Translations. This is a translation of exceptional merit.)

upon tablets of wood, which were supposed to have been discovered, like so many of the wonder-working eikons of modern Greece, by a person who dug them up in obedience to the instructions of a miraculous dream. They were kept in a chest made of the wood of an olive-tree, which had displayed magical properties, and from this chest, agreeably to the recommendations of Lucian or to the practice of the modern state lotteries in Italy, one of the tablets was drawn by the pure hand of a boy.

Practically any fortune-telling book of the many which circulate among the vulgar in all modern countries will be found to contain, usually at the end of the volume, a number of answers. Each of these is in some way labelled, e.g. by a number or by the name of a prophet or saint. In the earlier part of the book will be supplied the machinery for arriving at one of these numbers or names. The method of arriving at your number may, of course, be elaborated at will, and intricacy always impresses the ignorant. The simplest machinery is perhaps the squared chart upon which the names or numbers are inscribed. The questioner shuts his eyes and puts down a finger at random. If he then takes the number or name of the square upon which his finger lit and looks it up in the key, he will find, in the sentence against it, the answer to his doubts or to his question.

In classical antiquity such a table of answers was sometimes consulted, the number of the answer being ascertained by the throwing of dice. Pausanias, the Baedeker of ancient Greece, described such an oracle of Hercules at Bura in Achæa. "The person who inquires of the god prays before the image, and after praying he takes four dice, and throws them on the table. There are plenty of dice lying beside the image. Each dice has a certain figure marked on it, and the meaning of each figure is explained on the tablet." [1]

In the southern corner of Asia Minor a number of fragments of Greek inscriptions have been found, which give the responses of an oracle of this kind. One is arranged for a throw of seven dice, but the usual fashion seems to have favoured five. The Greek dice was a knuckle-bone, which had four numbered sides, with the values 1, 3, 4, and 6. With five dice the possible totals range from 5 to 30; but, while some of the intervening numbers, e.g. 6 or 29, cannot be made out of combinations of 1, 3, 4, and 6, others can be made by various combinations. Each possible throw, however, was given a name. Thus three distinct throws might give the total 22, viz. 1, 6, 6, 6, 3, which was called the throw of the Manifest Fates, 6, 4, 4, 4, 4, the throw of Poseidon, and 6, 6, 4, 3, 3, the throw of Raging Ares. It will be found that there are fifty-six possible throws, and the answers to all, except the twelfth, can be recovered, in whole or in part, from one or other of the inscriptions. Not that much is thereby gained, for the matter is sad rubbish and the manner displays the customary metrical defects of oracular verse. A couple of specimens may be quoted in Sir J. G. Frazer's translation:

1, 3, 3, 4, 4. 15. (The throw) of Saviour Zeus.
One one, two threes, two fours.
The deed which thou meditatest, go do it boldly.
Put thy hand to it. The gods have given thee favourable omens.
Shrink not from it in thy mind. For no evil shall befall thee.

6, 3, 3, 3, 3. 18. (The throw) of Good Cronus.
One six and four threes.
Haste not, for a divinity opposes. Bide thy time,
Not like a bitch that has brought forth a litter of blind puppies.
Lay thy plans quietly and they shall be brought to fair completion.

Something like these oracular tables are other inscriptions from Asia Minor, which contain twenty-four self-contained oracular lines, each of which begins with a different letter of the alphabet. Evidently here a letter of the alphabet was in some way selected by the questioner, and the line with which that letter began was the response.[2]

A method similar in general character which is popular in the Moslem world is the use of a table called a "Zairgeh." These may be very elaborate and their consultations may demand preliminary astrological calculations; but the simplest form, which will illustrate the principle upon which they work, employs a table divided into a hundred squares, each of which contains a letter of the alphabet.

Repeat three times the opening chapter of the Koran and the fifty-ninth verse of the sixth chapter —"With Him are the keys of the secret things: none knoweth them but He: and He knoweth whatever is on the land and in the sea: and there falleth not a leaf, but He knoweth it, nor a grain in the dark parts of the earth, nor a moist thing, nor a dry thing, but [it is noted] in a distinct writing." Then place the finger at hazard upon the table; write down the letter upon which the finger lights, and every fifth letter following, until you get back to the letter with which you started. The answer always begins with the first of the letters taken from the top row. Thus, if we start with the letter in the fifth row and the

[1] Pausanias, vii. 25. (Translation by Frazer.)

[2] Further details will be found in my *Greek Divination*, pp. 212 foll., and Frazer, *Pausanias' Description of Greece*, iv, p. 172.

seventh column of the analogous English chart, which Lane has cleverly constructed, we get w i l l d o ẇ r o n g w h o d o e s i t. Taking the first letter from the top row as our starting-point, this gives us "who does it will do wrong."

It is amusing to notice, with Lane, that the possibilities of the table imply a shrewd if somewhat low estimate of human nature. Clearly the author was of opinion that in four cases out of five when men turn to an oracle to obtain a sanction or confirmation for an intended action, their purpose is likely to be wrong or precipitate.

Urim and Thummim

The simplest method of all of deciding upon a course of action, where an alternative is possible, is to toss up, and methods of casting lots where the answer must be "yes" or "no," as with the "heads" and "tails" of a coin, are everywhere well known. This seems to have been the principle of divination by Urim and Thummim in the Old Testament. I have had letters from several correspondents with reference to a previous paper, suggesting, upon the basis of the common but erroneous belief that Urim and Thummim were two of the jewels of the breastplate of the High Priest, that they were used in a kind of crystal-gazing.

Unfortunately, the text of Exodus xxviii. 30, upon which this hypothesis rests, appears to be corrupt, and it is possible that the post-Exilic priestly author of the passage had himself but vague notions as to the exact method of this ancient national rite of divination. In any case, since this is the sole foundation for the jewel theory, it should be noticed that he does not as a matter of fact state that they were jewels of the breastplate. Modern Semitic scholars appear to agree that these objects were in fact two stones which were placed in a pocket or pouch of the ephod. One of these represented the affirmative or acquittal, and the other the negative or condemnation. In cases of doubt, one of them was drawn from the pocket and the decision accepted. The way in which an individual may be selected by such means may be seen in 1 Samuel xiv. 41 foll. First the test is applied to two groups—the people on one hand, and Saul and Jonathan on the other; the answer gives Saul and Jonathan. The test is then narrowed down to them and the lot falls on Jonathan. We may compare the method of Saul's election to be king as described in 1 Samuel x. 17 foll. The great advantage of such methods is, of course, that an answer one way or the other is inevitable.[1]

[1] See Hastings, *Dictionary of the Bible*, s.v. Urim and Thummim; Witton Davies, *Magic, Divination, and Demonology among the Hebrews and their Neighbours*, p. 75.

Modern Industries—VIII

Ironstone, Iron and Steel

By R. C. Skyring Walters, B.Sc., Assoc.M.Inst.C.E.

THE object of this paper is to describe the ironstone deposits at Scunthorpe, in North Lincolnshire, with a résumé of the principles involved in the conversion of such deposits into iron and steel by means of processes carried out at some of the largest and most modern works.

The origin of this great industry, like that of most, we may say all, other industries, is due in the first place to Nature's geographical distribution of the raw materials, and in the second, to Man's ability in converting such materials for his use and convenience.

Although this ironstone, the Frodingham Ironstone, covers some 12 square miles in area at (or near) the surface, and perhaps four times this amount at a depth of 300 to 500 feet below ground, and attains a thickness of no less than 30 feet, it is only during the last seventy years that the ironstone has been worked, and only during the war that a very large increase in working took place.

It is thought, however, that the indefatigable Romans must have worked the ore, owing to the discovery of Roman pottery associated with burnt remains within the area. Its modern rediscovery is locally told as follows:

Certain farmers were in the habit of burning the stone for lime to dress their land, over which shooting parties were wont to roam. One day a sportsman had his attention forcibly called to the stone by tumbling over a lump, which he found so extremely hard that he had the stone analysed. The result was that ironworks were established at Scunthorpe in 1859.

In 1860, 1,600 tons of ore were dug in the district, and the quantity won has steadily increased to nearly 2,700,000 tons in 1917; this has remained the maximum yield.

At the present time there are some twenty blast-furnaces for iron-making and as many more for steel, the manufacture of which was not attempted here till 1890. A good deal of the stone is sent away to other districts to be smelted with other ores, and similarly other ores are taken to Scunthorpe to mix with the Frodingham stone.

On the west the ironstone appears at the surface, and dips towards the east, in which direction it gains in thickness, and after being covered by an increasing amount of the Lower Lias clays, finally disappears

under the oölitic limestone hills. The bottom beds of the ironstone are generally the softest, and always so on the west, where they have undergone considerable weathering, as they are so near the surface. This weathering has increased the percentage of iron in the beds. These deposits appear as a soft brown crumbly limestone, 12 feet thick, as at present worked, but towards the east the thickness increases to nearly 30 feet and the stone becomes very hard and compact ;

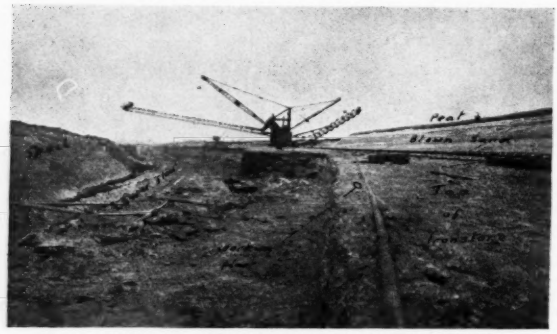


FIG. 1.—LORD ST. OSWALD QUARRY: GENERAL VIEW.

the lower layers are grey in colour and are rich in lime and poor in iron ; the middle layers, purple-brown and blue, and the upper layers, russet-brown. There are many fossil-shells ; and many of these are crystalline, having a pretty pink and green colour.

At the present time all the ore is worked in open quarries ; and it is estimated that there are some 150,000,000 of the original 200,000,000 tons still to be extracted. If the 1917 output is maintained, this would mean that in fifty years all the ore at the surface would be worked out, and mining underground towards the east would then have to be atempted.

With such objects in view, the nature of the ore has been tested in several boreholes put down through the Lincolnshire limestone, as it would not pay to sink so much capital in building enormous iron and steel works for a comparatively small life of fifty years ; further, research is being carried out as to the possibility, not to say probability, of finding *coal* at such a depth immediately below the ironstone as would be practicable to work. In this event, the conditions would be ideal, for at present all coal has to be brought some miles by rail via Doncaster.

Working the Ore

There are several methods of working this ore, which differ according to the amount of *overburden*, i.e. the blown sand and Lias clay, which has to be removed, and to the hardness of the stone ; thus on the western outcrop the frost-broken bottom beds are simply scooped up by the bucket of a small steam navvy which takes about a year to move along the rock face. This face is upwards of a mile long, the greatest depth of ironstone being 13 feet. The overburden of top soil and sand is here no more than 4 feet in depth, hence it is simply wheeled in barrows by hand across planks supported on high trestles to the rear of the working face. The overburden is then levelled over and is soon converted into allotments and agricultural land. The ironstone is, of course, not quarried under cottages, farms, and roads, hence such objects are conspicuous, standing high above the resultant lower ground level from which the stone has been taken. Where it is necessary, roads are tunnelled to afford a passage for the ironstone goods-trains to reach the main lines and works.

Where the stone is so weathered, little blasting is necessary for shattering the rock into pieces small enough to enter the opening in the particular furnace for which the stone is destined. But farther east, where certain beds of the stone are much harder, blasting is resorted to, holes being drilled or " jumped " for the purpose of inserting gelignite or other high explosive. In one quarry large holes 6 inches in diameter are drilled vertically on the top of the ironstone ; these holes are 15 feet apart and 20 feet deep. The rock is split into vertical fissures by large ammonal cartridges inserted into these holes, and is so loosened that powerful diggers are able to bite into the rock and put it on rail. Towards the east the overburden, too, becomes deeper and adequate machinery is in operation to deal with this, the object being to reduce the ultimate cost of iron ore per ton as much as possible. Such machinery, a bucket excavator and conveyor, is shown in Fig. 1, which removes the sand and peat (seen in the right-hand side of the picture) by a series of buckets on an endless belt. These carry the sand and peat to the centre of the machine, where it is picked up by a tip-wagon which runs along the long left-hand lower arm, from which it tips its load far behind the working face ; the two upper arms being merely girder supports to take the weight of the lower girders with their loads.

Fig. 2 shows a general view of the Great Yarborough Quarry, which extends a mile or so on the curve, and which was so much developed owing to the great impetus given to the *basic*-steel making process under the direction of Sir John Hunter during the war. The ironstone is attacked by high explosive and powerful steam-diggers. Several different companies have spheres of action within the area, and they give employment to some 1,000 men in times of normal trade, while some 8,000 to 10,000 men may be employed in the surrounding works.

Acid and Basic Steel

It has been pointed out already that the ore is used for making *basic* steel. This process is gradually replacing the older process, namely, the manufacture of *acid* steel. The chief constituents of the ores suitable for these two processes may be compared thus:

Locality:	Acid. Cumberland.	Basic. Scunthorpe.
Iron	50·0	15 to 25
Silica	7·0	8 to 15
Lime	1·0	10 to 25
Phosphorus	·03	·3

Although the weight of iron obtained from the acid ore is more than twice that obtained from an equal weight of basic ore, the latter is gradually superseding the former, notwithstanding the fact that several millions of capital have been sunk in the acid-steel process. This is due not only to the basic ores being near the surface and more easy to mine, but also to their chemical composition. In the acid ore the amount of silica is high, and consequently the fusion or melting point in the furnace is high, comparable to that in brick-making described in a previous article. Hence lime has to be added, which means considerable expense in quarrying and transporting. Again, in steel-making a valuable by-product, the phosphoric fertiliser, basic slag, is obtained which is not obtained in the acid process.

For iron-making both ores are smelted with coke in the blast-furnace, lime being added to the ore, and in the case of Scunthorpe ore, silica. The Frodingham ironstone contains so much lime in itself that it is nearly self-fluxing; in fact lime is in excess, and silica, from the siliceous ores such as those of Northamptonshire, is now often added. In the early days this fact was not recognised, possibly owing to the sandy appearance of the stone due to the little oölitic concretions of lime, and mistakes were made in adding lime. Now, however, by means of a judicious use of the siliceous ores, the lowest beds, containing perhaps as much as 25 per cent. of lime and only 15 per cent. of iron, are not only quarried but sought after, for the area where the top beds have been taken in the past is being reworked.

Roasting the Ore

A common process is to roast the ore in kilns, which drives off moisture and increases the iron from 25 per cent. to 35 per cent. The roasted ore, with a proportion of other ores, is then smelted with about half its weight of coke in the blast-furnace on which *hot* air is blown. It is essential that the air should be heated, and for this purpose there are two or more sets of high cylindrical structures with dome-tops filled with fire-brick; these structures are known as Cowper stoves. The hot gases given off from the furnace are made for a time to burn in and to pass through one set of stoves to heat the fire-brick, while in the other set cold air is passed through the fire-brick which has been previously so heated, and then the current of air, now heated, goes on in its turn to the furnace. In the furnace, the iron, which contains several impurities (including phosphorus), sinks by its own weight to the bottom; thence it is tapped twice a day and run into beds of sand, in which state it is known as pig-iron. The slag, which contains some 32 per cent. of silica, 17 per cent. of alumina, 14 per cent. of lime, and other substances in smaller proportions, floats on the top of the iron and is tapped from a higher level, run into trucks, and tipped on to neighbouring slag-banks. The chief uses for this slag is for ballast, hard-filling, concrete work, and road-making. The gases from the furnace heat the Cowper stoves and supply all the power required for the iron as well as the steel works, and are turned to useful account in innumerable operations.

The pig-iron obtained from both the acid and basic ores is suitable for all ordinary uses of *iron* alone, but *steel* made from the acid pig-iron must be made in a

FIG. 2.—YARBOROUGH QUARRY: GENERAL VIEW.

furnace lined with silica bricks, whereas that made from the basic pig-iron must have a furnace-bath lining of magnesite brick and other basic material.

Great difficulties were experienced during the war, as the whole of the pre-war supply came from Austria. With considerable economy, coupled with good organisation in handling the deposits of magnesite in Greece and in India, these difficulties were successfully overcome.

ADDENDUM

With reference to the article on Salts, Brines, and Alkalis of the December issue, the author, in his original communication, recorded his thanks to Mr. F. C. Calvert for the loan of photographs and to Mr. J. C. Williams for notes on the French Potash Mines.

Regional Survey

NOT a few of our readers will be interested in the following notes of a Congress recently held at Edinburgh, on the subject of Regional Survey, especially in its relation to Education and Re-education. MR. NORMAN M. JOHNSON spoke of the method he had been employing at Kinglassie School, in Fife, since the War, viz. giving unity to the school subjects by basing them upon the pupils' actual surroundings. He showed a number of the surveys prepared by his boys and himself, the various observations and finds, whether in geography, natural history, agriculture, or country economics generally, being as far as possible recorded on the 6-inch Ordnance Survey Map. The latest survey begun had been one of local field-names.

DR. A. J. BROCK (president of the Congress) spoke on "The Farm and Field Names of Greater Edinburgh and Fife." He declared that the time had now come for educators and doctors to be permanently associated in the task of what was nothing less than Preventive Mental Medicine; he held that one of the most potent predisposing causes of the symptom known to psychopathologists as "mental dissociation" was an education which presented knowledge to the young as a number of entirely unrelated "subjects"; the principle which would unify these subjects was, he believed, to be found in the actual environment of the child's school and home. In regard to the farm and field names of Greater Edinburgh and Fife, he showed that the main linguistic elements, Gaelic and Saxon, which constitute these raise interesting problems, geographical, historical, and economic. He advocated the investigation and mapping of local field-names as one of the most practical avenues of approach to the wider survey of the district. DR. W. G. SMITH, of the Edinburgh and East of Scotland College of Agriculture, spoke on "Edinburgh Rural and Urban." He held that the townsman has too much lost touch with "the spirit of the Soil" and looks on the country largely as a huge golf-course or sports-field, whereas to the countryman it is essentially his workshop. The townsman will better retain the genuine country spirit if the mountains and the seashore be left open to him. The demand for gardens and allotments is also a genuinely human demand. DR. C. G. LAMBIE, Assistant Physician at the Royal Infirmary of Edinburgh, speaking on "A Survey of Edinburgh Industries in Relation to the Requirements of the Physically Handicapped," showed how physical defects tended to lead, through idleness, to disintegration of character; but he pointed out that there was no fatal necessity in this, and that the process could be stopped at an early stage. It was urgent that suitable occupation should be provided for the physically handicapped, and to this end he appealed for a survey of the chief industries of Edinburgh; this would then be available *inter alia* for the social workers who are at present engaged in finding work for the victims of the War. MR. J. F. REES, Lecturer on the History of Economics at Edinburgh University, dealt with the "Regional Principle in Adult Education" particularly in relation to the Workers' Educational Association. He welcomed the Regional idea as a valuable basis for a general humane education; the study of the locality, for example, undoubtedly gives a touch of reality to history-teaching in schools. He recommended the W.E.A. to make a start with Regional Survey. MR. F. C. MEARS, Member of the Town-planning Institute, spoke on the relation between Regional Survey and the town-planning schemes which the municipalities of all our larger cities are engaged in framing; for instance, the Town-planning Committee of the Edinburgh Town Council were at present in need of a series of Greater Edinburgh Surveys exactly on the lines dealt with in the discussion of the Congress, and they looked to those of the public who were interested in the different departments to help them in the matter.

It was announced that a group had been formed for the collection of the field-names in the Greater Edinburgh district, for the study of these and for their recording on the 6-inch Ordnance Survey Map.

Among the Stars

A Monthly Commentary

The Problem of the Solar Corona

IN a paper communicated to the recent meeting of the American Astronomical Society at Mount Wilson, California, Professor Campbell, Director of the Lick Observatory, summarises the present state of our knowledge of the solar corona. This, the outer appendage of the Sun, has long presented a formidable problem to astronomers. It can only be observed on the rare occasion of a total eclipse of the Sun, all efforts to photograph it in daylight having failed. Consequently, our knowledge of the corona is necessarily limited.

Professor Campbell points out that the general form of the corona is dependent on the solar cycle. At the sunspot maximum the corona is circular in form; at the minimum, on the other hand, it is "characterised by weakness near the north and south poles of the sun, and by streamers of great length stretching out to the east and west." There is no indication, however, that spots, prominences, and coronæ are, in Professor Campbell's words, "closely related in the geometrical sense." There is, however, a more obvious connection between streamers and prominences than between streamers and spots.

As to the nature of the matter composing the corona Professor Campbell states that spectrographic and polarigraphic observations of the corona light indicate that the inner corona is partly gaseous and partly composed of minute solid particles, or gas molecules, shining by reflected sunlight; while the middle and outer corona owes its luminosity almost wholly to reflected light. At the Lick Observatory, Dr. Moore has undertaken measurements of radial motion; and the correct interpretation of his observations, says Dr. Campbell, "seems to be in favour of motion outward in the corona. The general

appearance of the coronal streamers is clearly in favour of motion outward from the Sun." The corona materials are being driven away from the Sun, never to return, just as the materials comprising the tails of comets are being driven off into space, probably by the same cause, the radiation pressure of light. "Astronomers would like to know," says Dr. Campbell, "if all the stars have coronæ, their coronal materials representing gradual losses of mass."

In 1885 the late Sir William Huggins remarked that "it is indeed possible that stars which have a higher temperature than our Sun are surrounded by coronæ of greater extent and brightness." The question presents itself as to whether the great irregular nebulæ are not, in a sense at least, analogous to the corona.

The Star Betelgeux

Mr. F. E. Seagrave, of Boston, Mass., has called attention to the increased brightness of Betelgeux (Alpha Orionis). Between October 29 and November 12 he found it to be two-tenths of a magnitude brighter than Rigel, while Mr. Boss, using the selenium photometer, finds it appreciably brighter than last year. Betelgeux is a giant star, and, with the single exception of Antares, it is the greatest material body in the Universe, according to our present knowledge. The Mount Wilson observers, who first measured its diameter in December 1920, have found the diameter to be variable, and the question naturally presents itself as to whether the variability in light and the change in diameter are interrelated. If this should prove to be so, the pulsation theory of the Cepheid variable stars will be materially strengthened.

News from Mars

In his twenty-sixth report on Mars, Professor W. H. Pickering deals with the changes of position of the darker markings on the planet's surface. During the last opposition in 1922, the dark area known as Elysium exhibited some startling changes. From spring to summer, the southern border of this area shifted 118 miles to the north, and its northern border 76 miles to the south. "After the summer solstice these motions were reversed, southern Elysium moving 18 miles southerly, while northern Elysium moved northerly 86 miles in the same time." Thus, the diameter of the area decreased from spring to summer by 194 miles, and increased during the autumn by 104 miles. Professor Pickering points out that this marking has long been known as variable both in position and visibility. Discovered by Dawes in 1864, and mapped by Proctor in 1877, it was seen by Professor Pickering himself in 1892 as "a small elliptical spot with a dark centre." In 1913 it actually extended 480 miles south of its mean position; while during the last opposition of the planet, it faded out altogether. These observations furnish further conformation, if such were necessary, of the view that these dark areas are tracts of vegetation.

Professor Pickering remarks that both Elysium and another shifting spot, Ismenius, are associated with canals, which also shift their positions. This, in Professor Pickering's opinion, conflicts with the late Professor Lowell's hypothesis of the nature and function of the canal system. "It does not appear, therefore," he remarks, "that these markings can be bands of vegetation watered by irrigation ditches, as is sometimes supposed. If, according to the other theory, we imagine that they are merely shower tracks or perhaps heavy depositions of moisture from fog, the chief objection appears to be that they shift less than we should expect. That they are deposited at night, and every night, if they are deposited at all, and possibly are formed in wide shallow depressed areas, as is the case with our fogs, may possibly help to explain their fixity."

These suggestions of Professor Pickering's do not, however, rule out the possibility of intelligent design behind the canal system, although they certainly militate against Professor Lowell's particular hypothesis. Some years ago, Professor Pickering himself discussed the possibility that vegetation might be caused to flourish in certain regions by the artificial localisation of fogs. "It is known," he remarks, "as a laboratory experiment that fog can be induced to form in a saturated atmosphere, if furnished with a sufficient number of minute solid nuclei on which it may condense. It is suggested that it might be practical to do this, either by electrifying the air in certain regions, night after night, or by some such similar means upon a large scale on Mars." On this theory the shifting of the canals is easily explained. "A certain shifting of the fertilised areas from time to time would doubtless ensure improved crops if the water-supply were insufficient to fertilise the whole, so that we can readily see an object for it." Professor Pickering is not committed to any one theory, but has set himself simply to ascertain the facts.

HECTOR MACPHERSON.

The Farne Islands

WE are glad to give publicity in this place to an appeal which has been issued for the purchase of the Farne Islands, off the north-east coast of Northumberland, as a bird sanctuary. On an area, in all, of about 80 acres, more than twenty species of birds breed regularly. The Common Tern, whose photo we have published on the cover, is to be found with many of his rarer brethren, once soundly and successfully admonished (as a correspondent in *The Times* relates) for stealing St. Cuthbert's oats as he sowed them during his saintly reclusion. There are far too few sanctuaries of this sort in England to-day, and it is a sad fact that many of our most beautiful bird inhabitants are becoming very rare. The landlubber fraternity of birds have their interests protected by many associations—perhaps the Selborne Society may be mentioned as pioneers and devoted friends. The sea-birds, however, are in real danger on these islands, which are far too popular with trippers for the comfort of nursling terns and puffins.

Mr. Collingwood F. Thorp, of Belvedere, Alnwick, is Hon. Secretary and Treasurer of the fund. £2,200 are required, of which over £700 have already been received.

R. J. V. P.

Foot-and-mouth Disease

THE science of medicine to-day has reached a stage at which it is impossible to consider the diseases of animals and of men as if they had nothing in common. We know that tuberculosis can be spread by tubercular cows to healthy children; and that rabies in dogs causes hydrophobia in man. We know also that cowpox can, by vaccination into human beings, prevent smallpox. At one time or another relationships of a similar kind have been suggested in other diseases; and scarlet fever and diphtheria are by some supposed to be spread by domestic pets.

It is probable that not enough attention is paid to the possibility of infection spreading to man from the presence in his midst of domestic animals, often living in the closest relationship. Last year there was a discussion, in the medical press, of the association between distemper in dogs and influenza in man. And foot-and-mouth disease—which, in its present outbreak, has cost the country £2,000,000 already—is another case in point. It is believed by many that human beings actually suffer from the same disease. It is, however, quite possible that it might be transmitted to man in a modified form; it might be the cause of many of those obscure epidemics in man which we loosely group under the heading "influenza."

However that may be—and the suggestion is quite without proof—it is clear that, like influenza, measles, smallpox, and many other diseases, foot-and-mouth disease is spread by a minute organism which can pass through a filter. That fact alone would warrant a boldly planned and extensive research into its cause, its cure, and its prevention. Any new light upon it could not fail to have most important bearings upon the questions raised by similar diseases among human beings. Strangely enough, men are always more willing to pay for research which will ease their pockets than research which will cure their bodies. It is said that there is some degree of official opposition to such research, on the ground of the danger of harbouring infection. We are sure that this is a short-sighted policy, and we believe that in fact plans are being considered for continuing work which was begun in November 1920. It is to be hoped that this is so; the question of slaughter or isolation as a solution of the problem is of quite secondary urgency.

R. J. V. P.

Books Received

British Museum: Pictorial Postcards (Monochrome). Study sets representing various objects in the several Departments of the Museum. [Price 1*d.* each; the set (1 to 240) 18*s.*]

Health and Conduct. By ARTHUR I. BROCK, M.D. (Edin.). (Williams & Norgate, 10*s.* 6*d.*)

Agricultural Implements. By G. H. PURVIS. (Ernest Benn, Ltd., 2*s.* 6*d.*)

Dairy Cattle. By JAMES MACKINTOSH, N.D.A., N.D.D. (Ernest Benn, Ltd., 1*s.* 6*d.*)

Reviews of Books

The Life of Sir William Crookes, O.M., F.R.S. By E. E. FOURNIER D'ALBE, D.Sc., F.Inst.P., with a Foreword by SIR OLIVER LODGE, F.R.S. (London: T. Fisher Unwin, Ltd., 25*s.*)

Sir Oliver Lodge writes a foreword to this human life of Crookes, and admits that he had not read it before commending it to the public. As a friend of Crookes to whom he was not drawn at first, and a sharer of his beliefs in Spiritualism, Sir Oliver Lodge has discharged the task with a brevity and comprehensiveness which gives us a much more pleasing picture of the man than that presented in the biography founded on some 40,000 documents as well as on the records of his work. Crookes was in one sense a non-professionally trained scientist. He began his work as an amateur, and by sheer force of persevering genius brought himself into the very first rank of scientific workers. He had the gift of philosophising as well as that of investigating. He saw before he discovered, and when endeavouring to make his discoveries his mind was frequently so possessed by his theoretical views that he overlooked obvious facts. For him there was only one thing to be done, and in doing that he had his whole mind concentrated on the result he wished and expected to achieve. He carried this habit into the everyday events of life, and the story of his over-chivalrous defence of his brother, developing into an ill-judged attack on men who knew facts he could not have known, was characteristic of his general outlook. Shrewd and well aware of the commercial value of discoveries, he allowed himself to be used as a decoy by those who were more wordly-wise than himself, and in consequence found that he was the poorer by his association with the men who knew exactly his weak points and the value of his name with the public. He was frequently conscious of his own defects, and the way in which he appealed to his friend "Lallah" to help him in giving his addresses the literary flavour that was so much admired, proves him to have been as generous in his appreciation as he was wise in the use of the aid. As a man Crookes does not appear in many pages as lovable, but his affection for his wife and his attachment to his family show that he had two faces—one with which he faced the world and the other which he showed those he loved.

Crookes was born in 1832 in Regent Street, where his father was a tailor, and died in 1919, after seeing the land he loved come through the Great War. He had lived through the period of scientific and industrial expansion, and in his old age he was employed in exercising a general supervision over the Advisory Committees of the Royal Society. At the age of eighty-three he invented a signalling lamp by which signals could be sent without disclosing the fact that signalling was going on, but it was found impracticable by the Admiralty. He helped the Board of Invention and Research, that had its headquarters at the Admiralty, where in the words of his biographer he and his colleagues "enabled the Government to 'muddle through,' and it was they who finally overcame the appal-

ling menace of the submarine. It cannot be said that Crookes was of any particular use in such positions. He was failing in health and his heart showed frequent irregularity of action." We may add that his peculiar type of genius as shown in his life was much better adapted to individual than to team work.

Crookes never went to a University, he never learned foreign languages, and at the age of sixteen he became a student of the Royal College of Chemistry, where Hofmann soon discovered his ability and extraordinary carefulness in work. At the age of eighteen he became his junior assistant, and a year later, as senior assistant, he published his first contribution on the "Selenocyanides." His family became prosperous, and he might easily have drifted into the ranks of amateur sciolists who employ their talents in following by-paths and working unsystematically. "He felt fit to be in the front rank, he asserted his right to be there, he established a good title to his place, and maintained it against all competitors to the end of his life." Spectroscopy fascinated him, and he was enabled to anticipate in some measure the law of Kirchoff and Bunsen, "according to which a metallic vapour absorbs the rays of the wave-length of those which it emits." His work seven years later began to bear rich fruit, for in 1861 he first discovered the green line and saw the probability of a new element being in existence, and the following year he was able to exhibit thallium as a heavy black powder. From that time his place was assured as an investigator of the first rank, and in January 1863, at the age of thirty-one, he was elected a Fellow of the Royal Society. Three years before he had founded the *Chemical News*, which still continues its prosperous career. Those connected with scientific newspapers will find much to interest them in the narrative of its early years of struggle and triumph. We pass over his contest with Lamy for priority in the discovery of thallium, his campaign against the cattle plague, and his researches and troubles in connection with his interest in the utilisation of sodium in gold and silver amalgamation. His journey to Oran to observe the solar eclipse ended in disappointment, as the weather was not kindly, but it gives us a glimpse of the extraordinary methodical habits of the man, who took every possible precaution for his welfare on the expedition. He then passed through a period of comparative barrenness as far as exact science was concerned, and in 1874 again threw himself into his proper work. He found the atomic weight of thallium and worked hard at phenomena shown by his observations *in vacuo*. He devised the radiometer, which caused a great sensation throughout the scientific world. Crookes did not himself light on the explanation of the action of the instrument, but demonstrated the truth of the theory put forward by Professor Schuster, which attributes the motion of the vanes to the action of heat. As President of the British Association he delivered his famous address on the Wheat Problem, in which he displayed the amazing versatility of his mind. Those who heard him remembered his wonderful Crookes tubes, his contribution to the problem of electric lighting, and his hypothesis on the Genesis of the Elements. Lord Kelvin said the address on the last subject placed Crookes, "not second to Faraday, not second to Joule, but following both and crowning both." In 1913 he was elected President of the Royal Society—an honour that crowned a life that had been acknowledged by the King in 1910 by the bestowal of the rare and coveted membership of the Order of Merit. He had made British science world-famous by his many-sided activities in following up the work of other scientists in connection with the discoveries and identification of new elements and the elucidation of the many problems raised by radium and its properties.

For the general public, interest in Crookes centres in the attention he paid for four years to "the scientific investigation of psychic force." The death of his brother had deeply moved him. He had a mystical vein in his nature, and like all who have loved and lost, felt the yearning for communication with his dead friends. At that time there was a wave of spiritualism passing over England, and Crookes was much attracted by the accounts he had heard. In 1869 his friends and relatives were busy investigating professional mediums, and in 1870 Crookes himself was publicly drawn into the matter, having had his interest awakened in the summer of the previous year. Dr. Fournier d'Albe gives us many letters and descriptions of the séances he attended, and in May 1871 Crookes wrote: "At present all I am quite certain about is that they [obscure phenomena] are objectively true. I have had all my wits about me when at a séance, and the only person who appeared to be in a state of semi-consciousness is the medium himself. The other evening I saw Home handling red-hot coals as if they had been oranges." We do not propose to follow Crookes and the mediums in their conflict with friends who did not accept their views. Readers should pay special attention to the *faux pas* made by him through neglecting the fact that a force of as much as twelve to fifteen ounces can be transmitted to a board supporting a bowl of water by simply immersing the hand for some time in the water contained in the copper vessel, which had a hole in it and was half immersed in the water. Crookes had overlooked the elementary fact of hydrostatic pressure of the water displaced by an immersed hand. This blunder caused the break between official science and spiritualism. Dr. Fournier d'Albe makes the comment: "One cannot help wondering what the world would be like to-day had Crookes carried official science with him." To the end of his life Crookes believed in the objectivity of the strange events he witnessed in séances, in his British Association Address he said: "I have nothing to retract. I adhere to my already published statements. I only regret a certain crudity in those early expositions, which no doubt justly militated against their acceptance by the scientific world." It says much for the scientific world that one who was heterodox on this subject should have received the highest honours within its power to bestow and—this is at once a tribute to Crookes and an honourable trait in British science—that good work well done by any man is rewarded, no matter how much his private opinions on some branches of investigation may run counter to the convictions of his scientific brethren.

Books Received

Mention in this column does not preclude a review.

Making the Weather. By ALEXANDER MCADIE. (New York: The Macmillan Company, $1.00.)

Annuaire pour l'An 1924. Publié par le Bureau des Longitudes. (Gauthier-Villars et Cie, 6 frs.)

The Journal of the Science Association. Maharajah's College, Vizianagaram. Editor: Y. VENKATARAMIAH. (Printed and published by Hoe & Co., "Premier" Press, Madras.)

Speculations. Essays on Humanism and the Philosophy of Art. By T. E. HULME. (Kegan Paul, 10*s.* 6*d.*)

Bulletin of the Cleveland Scientific and Technical Institution. Vol. III, No. 3. Editor: EDWARD L. JOHNSON, L. ès S., F.G.S., Corporation Road, Middlesbrough. (Subscription, 10*s.* 6*d.* per annum.)

Ergebnisse der Exakten Naturwissenschaften. (Berlin: Verlag von Julius Springer.)

Technical Writing. By T. A. RICKARD. (Chapman & Hall, 10*s.*)

The Problem of an International Auxiliary Language and its Solution in Ido. By LUTHER H. DYER. (Sir Isaac Pitman & Sons, Ltd., 6*d.*)

Landscape and History. (H. R. Grubb, Ltd., 1*s.*)

Luxor and its Temples. By A. M. BLACKMAN, D.Litt. Illustrated by MAJOR BENTON FLETCHER. (A. & C. Black, Ltd., 7*s.* 6*d.* net.)

Correspondence

To the Editor of DISCOVERY

SIR,

I shall be glad if you will allow me to offer a few words of comment on the letter of your correspondent CIVIS. If I have rightly understood what he is contending for, I can support it by what seems to me a cogent example.

CIVIS indicts the body of scientific men, charging them with neglect of "order and unity"; in a word he affirms their lack of scientific vision. By scientific vision I mean—and I think your correspondent means—a design of life and action controlled by two principles. One principle is to be in accord with Science; the other is to be sure that one's work is serving the interests of the community. In this sense can it be maintained that men of science, as a body, are moved by the kind of vision which inspires and guides action?

Take for an example the great post-war question of National Economy. Carry the mind back to 1916. The crisis of the war was upon us. We were threatened with national disaster. It became a matter of prime urgency to conserve our energies, and, in particular, to use economically the energy derived from our annual output of coal. A Coal Conservation Committee was appointed. A dozen of our leading engineers were assembled with specific instructions. Their labours were kept to the point by the judicial and philosophic mind of Lord Haldane as chairman.

The investigation demanded arduous research. It took some two years to contrive a workable scheme. So it happened that the war was drawing to a close before the Committee issued its Report. Their policy of National Economy consequently received little attention. And after the war, it lay neglected on official shelves until the recent General Election. Then one of the three Political Parties dug it out; but it would seem, only in order to apply it to the problem of abnormal unemployment.

What, then, is the situation to-day as regards this masterly piece of research, and the resulting plan of action? After five years of neglect, running with alternate clamour for Reconstruction and Economy, a matured scheme of Economy and Reconstruction is impaled on the horns of partisan controversy!

Now, if I have rightly understood the point of view of your correspondent CIVIS, the Report of the Coal Conservation Committee embodies what he calls a scientific vision. Its plan of action is nothing less than a systematic application of physical science to national welfare. But what has been the attitude of scientific bodies towards this plan? Has any one of all our scientific societies lifted a finger to advance, or even to consider, its practical application? If so, where and when?

I am, etc.,

ENGINEER.

To the Editor of DISCOVERY

SIR,

The valuable communication from CIVIS in the current number of DISCOVERY should rouse many of us who are working at the *disjecta membra* of the body of Truth to a renewed interest in the relation of these to each other and their co-ordination into an ordered whole reflecting, by means of the mind of man, that ordered universe which we must assume to exist. Now as it is the means through which this great task is to be accomplished, agreement on the mind of man, or in other words human personality, appears to be the first requisite. This subject has been raised before in your columns, notably by Mr. Charles E. Hooper in the December issue of 1922, whose letter is well worth consideration by those interested in this problem. The correspondence arises from a suggestion in the Editorial Notes that a conference on Human Personality might well be held between representative theologians and scientists as a step towards a unified view of the universe.

Is it not possible that some attempt might yet be made to bring together scientists and theologians over such a discussion? The mere interchange of letters is not a satisfactory method, personal intercourse during some period of time with informal discussion would be of great value, and if some agreed statement could be issued as a result a real step forward would have been taken.

I would appeal to the Editor to take early steps towards ascertaining the practicability of such a conference.

Yours faithfully,

SYBELLA BRANFORD.

THE PINDARS, HASTINGS.

January 1924.

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